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SOME TESTS OF SURFACE DURABILITY OF BOTTLE GLASS

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Abstract

Glass surfaces or samples, as received, were tested for attack by moisture as well as by acids and alkalis. A number of container glasses, a pressed-ware glass, and a borosilicate glass were compared. Attack by moisture was studied by exposing samples to high humidity at an elevated temperature (50°C.) for 30 days and observing the resulting surface deterioration. Attack by alkali and acid, respectively, was measured by loss in weight in 2N caustic soda solution and constant boiling hydrochloric acid. The dimming test offers a criterion of the surface durability although no differences could be noted in the deterioration of the side walls and bottoms of the containers. The alkali and acid tests were inconclusive and no definite relation could be established between these tests and the chemical composition of the glasses.

TABLE I
Approximate Percent Composition

Glass	Classification No. in the Humidity test	Loss in wt. Alkali test mg/100 cm²	Acid test mg/100 cm⁺²	SiO_2	Al_2O_3	CaO	MgO	BaO	Na_2O	B_2O_3
I	1	83.9	0.2	81.0	2.0	..	..	..	4.0	13.0
D	2	80.5	2.0	72.5	3.5	4.0	2.5	..	16.5	1.0
B	3	61.1	2.0	72.4	3.5	6.4	..	..	16.7	1.0
A	4	61.0	0.5	72.3	3.5	6.4	..	..	16.9	0.9
F	5	59.8	2.1	74.0	2.3	5.5	0.1	0.5	17.3	0.3
J	6	49.2	0.9	73.5	2.4	3.5	2.4	..	17.6	..
C	7	71.8	2.0	74.9	1.4	3.6	2.7	0.5	16.9	..
E	8	60.7	0.8	73.6	0.8	4.3	3.2	1.0	17.1	..
H	9	43.6	0.3	73.8	0.9	5.4	3.8	0.5	14.8	0.8
G	10	51.7	3.2	74.0	0.5	5.9	4.1	0.4	15.2	..

Studies of various methods of testing durability of glass have revealed that no single method is completely satisfactory for all types of glass, nor even for various forms of glass of a single type. The so-called powder tests, which have been utilized a great deal, furnish a test of glass as "glass" and not of glass in the form in which it is used commercially. For testing containers in their commercial form, there have been devised autoclave tests of various sorts, which have worked out quite satisfactorily. There has been no surface test which is particularly adaptable to testing exterior surfaces of bottles as well as interior surfaces and for comparing fire polished surfaces with ground and polished surfaces, and so forth.

As a preliminary step in the development of a suitable surface test, several glasses were tested by subjecting their surfaces to attack by moisture and by hot alkaline and acid solutions. The glasses were obtained from several sources and represent generally various types of bottle and container glasses, although sample "J" was taken from a piece of pressed ware. The compositions of the glasses are shown in Table I.

Three different methods were used for comparing the durability of glasses, namely: (1) A humidity chamber test where the corroding agent was moisture at 50°C. (2) An alkali test in which the glass samples were subjected to 2 N sodium hydroxide solution at a temperature of 100°C. (3) An acid test in which the corroding agent was constant boiling hydrochloric acid.

In all cases the glass samples were washed in tap water and dried before testing, and an additional washing treatment was given to the samples used for the humidity chamber tests. Details of the test methods are given below.

Humidity Chamber Test Method: Glass samples, approximately 10 cm. x 10 cm., cut from side walls and bottoms of the containers, were washed in tap water, dried rapidly with clean cloths, washed in alcohol (95%), rinsed in distilled water, and dried rapidly with clean cloths or Kleenex tissue.

Six such samples were placed on a glass rack made of Pyrex-brand tubing, and the rack and samples were kept in a covered jar containing about 2½ inches of water (see Fig. 1). The jar, of Pyrex-brand glass also, was heated in an electric oven maintained at a uniform temperature for a desired time. The oven was a force-convection type, and the temperature was quite uniform and controlled to about ±1.0°C. A temperature of

50°C. was found to be suitable and was chosen because it corresponds roughly to the maximum temperature attained in shipment and storage, especially in tropical countries.

Samples of glass exposed under the foregoing conditions showed deterioration in 2 to 30 days depending on the composition of the glass and the time of exposure. The glass might be only slightly dimmed or a heavy white crust or film might have formed on the surface. The surface effect was judged by viewing the glass in strong oblique illumination, and the glasses were rated on their appearance after definite exposure for 30 days in the humidity chamber.

Alkali Test Method: The resistance to alkalis was determined by the loss in weight of a sample, approximately 10 cm. x 10 cm. in size, after treatment in a 2N sodium hydroxide solution for five hours at 100°C. The results have been expressed as loss in weight in milligrams per 100 sq. cm. of surface area.

Acid Test Method: The resistance to acid was determined by the loss in weight of a sample, approximately 10 cm. x 10 cm. in size, after treatment in the constant boiling mixture of hydrochloric acid (20.24% acid) for five hours at 110°C. As with the alkali tests, the results are calculated to a unit area basis and are shown as loss in weight in milligrams per 100 sq. cm.

Results: The results of the tests are shown in Table I, where the glasses are arranged in order of their appearance in the humidity test. Glass I was a borosilicate type and was perfectly clear and showed no deterioration after 30 days exposure. The amount of dimming increased progressively in the order shown with glasses D, B, A, F, and J, while glasses C, E, H, and G showed a definite scum and notable deterioration. The order in which the glasses fell was unmistakable when the samples were viewed by means of oblique illumination in a concentrated light beam. In a broad sense, the glasses that were high in alumina showed the greatest resistance to attack in the humidity test.

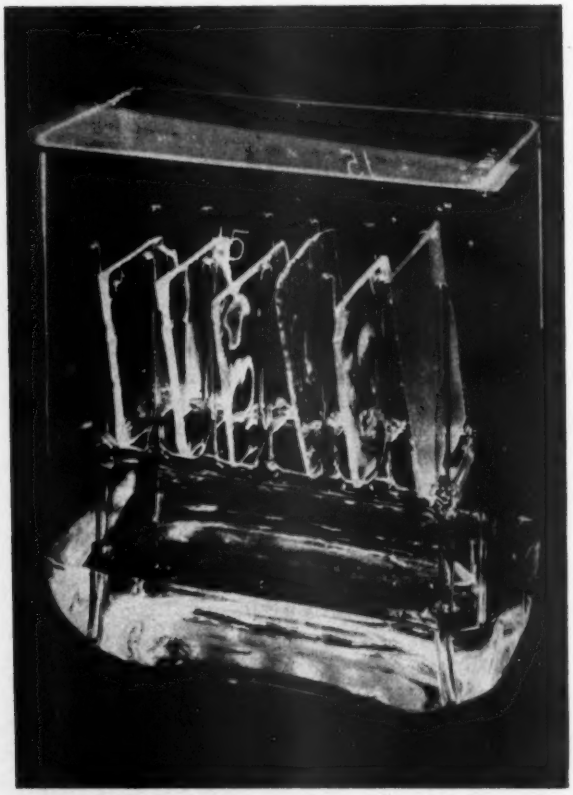

Fig. 1. Humidity cell and sample rack.

No noticeable difference was observed in resistance to attack of side walls and bottoms of bottles. If the bottoms were bad, the side walls were also bad in practically all cases and, if the bottoms were good, the side walls were also good. In several cases, the effect of the cutting shears of the feeder could be seen as a series of light gray streaks running in many directions from a common center, and appeared to be an important factor influencing the pattern of dimming.

Results of the solubility tests made in 2N sodium hydroxide solution are shown in the third column of Table I. Glass I, being a borosilicate type high in silica and low in alkali, gave the poorest results. Glasses D, B, and A, which are fairly high in alumina and were high in their resistance to moisture in the humidity test, were rather poor in their resistance to alkali.

Results of the tests in acid are shown in the fourth column of Table I. Glass I was the best in its resistance to acid solution, as is to be expected from its high silica and low alkali content. Glass H was outstanding in respect that it offered strong resistance to both alkali and acid attack. There is a noticeable discrepancy in the results of the acid resistance of glasses A and B. These glasses are very similar in composition yet glass A showed only 0.5 mg. loss and glass B 2.0 mg. loss. The results with these glasses in the humidity test and alkali test, on the other hand, checked very closely.

Conclusions: A humidity-chamber test is described in which the difference in the surface dimming of various types of glass may be taken as a criterion of the surface durability. No distinct differences could be noticed in the weathering tendency in the side wall and bottom of the container. The effect of feeder shear cut off was pronounced in the dimming pattern produced in weathering.

The results of the alkali and acid tests were not conclusive.

Acknowledgment

The author wishes to express his appreciation to the Hazel-Atlas Glass Company for furnishing the samples and to P. W. French for his assistance in carrying on the laboratory work. These studies were made at Mellon Institute, Pittsburgh, Pennsylvania, where the author formerly held an Industrial Fellowship.

CONFERENCE ON GLASS PROBLEMS CANCELLED

The annual Conference on Glass Problems for 1950, sponsored by the Departments of Ceramic Engineering of the University of Illinois and The Ohio State University, has been cancelled. Certain unanticipated circumstances in Columbus have made this action necessary.

The next annual Glass Conference will be held under the direction of the Department of Ceramic Engineering of the University of Illinois at Urbana sometime in 1951.

PRACTICAL PROBLEMS IN THE HEAT TREATING OF FLAT GLASS

By H. A. McMASTER

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Some attempts were made about 100 years ago to make tempered flat glass by quenching hot plates in oils. These apparently were not commercially successful. Later some patents appeared covering the use of steel plattens for quenching. These patents are followed by several small refinements which reveal some of the difficulties encountered and what steps were taken to correct them. One apparent difficulty would be marring of the surface. Another would be non-uniform cooling because the plattens and the glass would not be in actual contact at all points. A paper thin film of air would ruin the temper.

Most books on glass technology written before 1930 briefly mention heat toughened glass and dismiss the subject by saying that no practical uses have been found for this article. Good commercial tempering was not achieved until the air quenching patents of the early 1930's. These have been followed by numerous refinements and improvements are still being made. Millions of square feet are now produced annually.

Flat glass is usually supplied in a well annealed state so that it can be easily cut and fabricated. When glass is fully tempered, it cannot be further cut or ground, so it must be prefabricated as required by its intended use before tempering. The cost of tempering must be justified by imparting some desirable or indispensable property to the finished product. The great mechanical strength of tempered glass makes it valuable for glass doors, store fronts, navy porthole glass, back stops for ball fields, shelves, etc. Its ability to withstand thermal shocks and gradients makes it valuable for windows in oven doors, radiant gas heaters, automatic washers and driers, and arc lights. Tempered glass also has a safety feature derived from its high strength and fine break pattern which makes it valuable in automotive and television windows.

Although the problems of tempering flat glass are not as complex as those of tempering hollow ware due to the essentially uniform thickness and equal accessibility of both surfaces of flat glass for heating and quenching, there are the added problems of keeping large areas flat, preserving optically clear surfaces, and minimizing the marring caused by the supports. The most popular means of supporting large pieces of flat glass is by using tongs made on the principle of ice tongs. Glass sheets as large as five feet by nine feet have been tempered using numerous tongs along one edge for support. It is very difficult to keep these large sheets flat because of faulty tongs and variations in heating and cooling from one area to another.

Small pieces of glass can be supported along the bottom edge with a hairpin of fine wire over the top edge to keep the glass upright. Glass will warp or sag when so supported unless the temperature is carefully controlled. Small pieces of glass can also be tempered in a horizontal position by supporting them at numerous points around the periphery.

The supports in all cases must be made of heat resisting material and designed not to obstruct the air from reaching the glass. Care must be taken to prevent the glass from fusing to the supports or being stained by them. The glass and support must be permitted to expand and contract independently to prevent breaking the glass while the surfaces are in tension during cooling.

The success of the tempering operation depends to a great extent upon proper heating. Large areas of flat glass can be suddenly inserted into a white hot furnace without breaking because all surfaces immediately become compressed, and since the thickness is fairly constant, all areas heat at substantially the same rate. If holes are placed too near the edges or corners of the glass, the remaining strips of glass between the holes and the edges will heat too fast because of their larger surface areas and may break. Holes should be at least six times the thickness of the glass from the edge. Flaws in the central layers which are under tension during heating may cause breakage.

Electric furnaces are generally used for heating because they supply a uniform radiant heat and are simple to control. The heating elements can be divided into several separate zones to automatically provide for small or large pieces of glass and to help compensate for cold air at the bottom of the furnace.

Radiant tube and muffle type gas furnaces have also been successfully used. They are not as flexible and easy to control, but the economy of gas heat justifies their use. Open gas burners which discharge the products of combustion into the heating chamber are not very satisfactory. The hot gases rise to the top of the furnace and set up a large temperature gradient. When a load is inserted into such a furnace, a large volume of hot gas is produced by the burners causing the thermocouple to heat rapidly and turn the gas off before the walls and load have been heated. This makes it difficult to regulate the temperature and time cycle. Gas used in open burners must be quite free of sulphur or the glass will be fogged or stained.

Hot liquids are not used, to my knowledge, for heating plate or window glass for tempering. The problems of staining and removing the liquid from the glass would handicap commercial use of this method. Glass tempering furnaces should be built specially for that purpose. Metal treating furnaces usually do not have the necessary temperature uniformity. The viscosity of most glass changes by a factor of two for each 15°F. at the tempering temperature and unless the proper heating cycle is maintained, tong pull and warpage can easily occur.

For the most part glass can be considered as heating by radiation when placed into a furnace at a bright red temperature. Convection is probably more of a nuisance than a help. The net rate of exchange of heat between

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Presented before the Eleventh Conference on Glass Problems, University of Illinois, Urbana, Illinois.

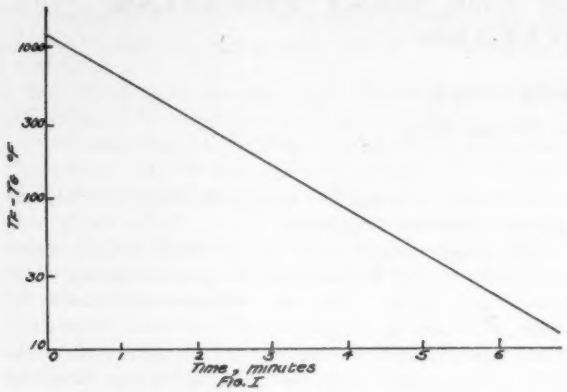

Fig. I

two black bodies is a function of the differences of the fourth powers of their absolute temperatures,

$$R = A\left(T_1^4 - {}_2^4\right) \tag{1}$$

If the furnace temperature, T_F, is maintained constant, the net heat absorbed by the load will cause its temperature, T_L, to increase at a rate

$$\frac{dT_L}{dt} = B\,(T_F 4 - T_L 4) \tag{2}$$

assuming constant heat capacity implied in B.

It has been found by experiment that glass heats slower than a black body would according to equation (2) above. The heating rate of glass measured under factory production conditions is more closely represented by

$$\frac{dT}{dt}\,G = C\,(T_F - T_G) \tag{3}$$

Where T_G is the glass temperature, T_F is the furnace temperature, and C is a constant.

The upper line (2) of Fig. I shows how the temperature of glass would have to increase with time to obey Eq. (2) and the lower line (3) shows how the temperature actually increases as represented by Eq. (3).

The chief difference is the slower initial heating rate which may be due to cooling of the furnace walls by the glass and the transparency and low absorptivity of the glass to radiation from the furnace walls. At any rate, the actual time-temperature curve does not agree with that calculated for a black body nor for a gray body of low absorptivity. By plotting time-temperature data on semi-log paper using time as the abscissa and log $(T_F - T_G)$ as the ordinate, a substantially straight line results as in Fig. II.

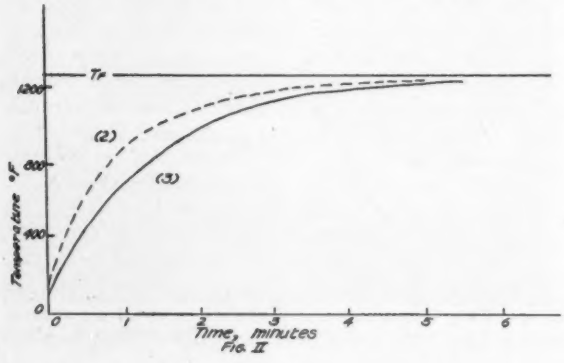

Fig. II

By integrating equation (2) we get

$$\text{Log}\,(T_F - T_G) = -Ct + D \tag{4}$$

which is also represented by Fig. II and fits the data well. Trials have shown that equation (4), which is the integrated form of (3), fits the data over a wide range of furnace temperatures and glass thicknesses and colors. Knowing this, only one reading made while the glass is heating is enough to establish the constants C and D since the initial glass temperature is the same as room temperature. With C and D known, the temperature after any heating time can be calculated using equation (4) or graphically determined by Fig. II. Furthermore, tests have shown that the constant C which is the slope of Fig. II does not change with furnace temperature T_F. The constant D for any furnace temperature is simply the log $(T_F - T_R)$ where T_R is room or initial glass temperature. Therefore, by drawing a new straight line parallel to the one above and intercepting the vertical axis at log $(T_F - T_R)$, the glass temperature after any heating time at the new furnace temperature can be determined.

The above procedure is strictly empirical, but has considerable practical value when new heating cycles are to be set up and limited data are available. For example, when time-temperature data are plotted linearly as in Fig. I, it can be seen that the glass approaches the furnace temperatures asymtotically as time goes on. If the furnace temperature is only slightly above that which the glass must reach to be plastic enough to temper, considerable time must be spent in the slow heating or "soak" part of the curve. During more than half the time required by such a cycle, the glass is soft enough to slowly sag or warp on its supports. Under these conditions, the tongs may pull a tab of glass one-eighth inch long beyond the original edge of the glass.

If the furnace temperature is raised high enough, the glass reaches the tempering temperature while it is still heating rapidly on the steep part of the time-temperature curve and the glass spends very little time in the plastic state before it can be removed from the furnace. Tong pull and warpage can be greatly reduced by rapid heating with high furnace temperatures. Before the full benefits of rapid heating can be achieved in practice some other factors must be considered.

Let us consider the effect of thickness on heating rate. When the furnace temperature is held constant and the time-temperature data for several thicknesses of the same type of glass are plotted semi-logarithmically, the slopes of the lines obtained become much steeper for the thinner glass which is to be expected. If the reciprocal of these slopes is plotted against thickness, a nearly straight line results which does not pass through the origin of the co-ordinates as it would for a black body. As the glass becomes thinner it becomes more transparent to the heat rays and does not heat as fast as an opaque body would.

This decided variation in heating rate handicaps the

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GCMI AGAIN MEETS AT SEIGNIORY CLUB AFTER NINE YEARS

The Seigniory Club, Quebec, was the scene of the semi-annual meeting of the Glass Container Manufacturers Institute, Inc., October 16-18. L. F. Gayner, Chairman of the Board of Trustees, called the gathering to order. In discussing the present high rate of production, he felt that business should continue at its present level for the balance of the year. However, as he pointed out, the industry is oversold from 3 to 5 months, due to the shortage of soda ash.

Following the usual procedure, the first two days of the meeting were devoted to presentation of reports from the nine standing committees, beginning with Market Research and Promotion. This group, of which F. H. May of the Foster-Forbes Glass Company is Chairman, reported that consumer advertising support of the One-Way bottle by brewers and grocers has been greater during the five months preceding the meeting than for any similar period since the inception of the campaign. An informal survey has revealed that 104 brewers, representing a 36-million barrel production, are behind the GCMI campaign, important newcomers being the Schlitz and Pabst Brewing Companies. Almost every major brewery in the country, the Committee advised, wrote in for copies of the Beer Merchandising Manual, which was offered on request in the July-August issue of *Glass Container News*, the Institute's house organ.

On the baby food front, the Committee reported that its major effort has been a cooperative promotion with the National Tea Company and its 365 store units in the Chicago area, following the pattern of previous successful promotions with the Jewel Tea Company, Chicago, and the Kroger Grocery Company, Cincinnati. Through the use of a give-away glass bowl, backed with newspaper advertising, $75,000 worth of baby food in glass was sold in a ten-day period. Baby food sales in glass the week of the promotion, and for two weeks thereafter, were 30 per cent ahead of an average three weeks and 25 per cent of the same period a year ago. Store traffic went up 10 per cent during the period of the promotion, and the National Tea Company called it the best baby food promotion they ever had.

Substantial progress was also reported in the development of a promising initial program for milk bottle promotion. While waiting for funds to be raised, the Committee is proceeding with a test market approach in Fort Wayne, Indiana. The Committee also lauded the work of the West Coast promotion staff, pointing out that experience in that area conclusively demonstrates the promotability of the One-Way bottle and justified its backing with a substantial amount of consumer advertising, as well as continued merchandising in the coming year.

The Committee on Labor Relations, headed by L. C. Roche of the Maryland Glass Corporation, gave a summary of its activities in the field of pensions, and also of the steps leading up to the new agreement between the industry and the Glass Bottle Blowers Association, and that with the A.F.G.W.U.

The trend in wage settlements since the agreement was made with the G.B.B.A., the Committee disclosed, has been toward larger increases in wages and other benefits—a trend which probably will continue upward unless, and until, wages and salaries are frozen. As to the Defense Production Act of 1950, the Committee predicted that the legislation might result in the regulation of all wages and prices, save for a few industries, in which case there will be a board similar to the War Labor Board of World War II.

The report of the Institute's Traffic Committee commented on the reduction in rail freight rates that became effective within Eastern (so-called Official) territory April 21, 1950. Chairman I. L. Dunnington of Anchor Hocking Glass Corporation said the Eastern railroads adjusted the rates on glass containers downward to meet motor truck competition. He said the lower rates had been published to expire April 20, 1951 and that this expiration had been fixed by the railroads so as to give them an opportunity at the end of one year of determining whether or not the adjustment had accomplished one or both of two objectives: first, if it had recaptured any traffic already lost to highway competitors and second, if it had halted in a substantial way the progressive diversion of glass container traffic from the rails to the trucks. Mr. Dunnington said the acute shortage of railway cars the past several months was unquestionably responsible for the railroads losing considerable traffic to their highway competitors, which otherwise might have been turned to them. He said the Committee had called this situation to the attention of many of the important roads and that they recognized it as a disability which would have to be taken into account when extension of the lower basis of rates beyond next April is negotiated.

Mr. Dunnington also reported that, largely through the efforts of individual glass companies, the rail rates on glass containers within Southern territory were reduced effective September 15, 1950. He said that, as was the

Canadian glassmen, left to right: I. R. Macdonald, General Sales Mgr., F. N. Dundas, Secretary, T. W. Bassett, Vice President and General Manager, all of Dominion Glass Company, Ltd.; G. F. Jones, Consumers Glass Company, Ltd.; H. MacDonald, Dominion Glass Company, Ltd.; J. N. Jordan, Consumers Glass Company, Ltd.; and A. P. Calcomb, Dominion Glass Company, Ltd.

Two Berts and a Girl. Bert Cremers of Wyandotte Chemicals Corporation talks show business with entertainers Vivienne Allen and Bert Sheldon.

case in Eastern territory, the purpose of this adjustment was to narrow the spread between rail and motor truck rates in the interest of meeting motor truck competition.

Concerning the matter of rail rates on glass containers in Southwestern territory, Mr. Dunnington said the Committee was now carrying on negotiations for lower rates in this region.

In Mr. Dunnington's report, considerable was said about I.C.C. Dockets 28300 and 28310. These are the two freight rate proceedings, designed to bring about uniformity of classification ratings and the establishment of a single class rate scale for application throughout the country, which have been pending before the Interstate Commerce Commission since 1939. They are probably the most controversial freight rate matters ever to come before the shipping public. The report of the Traffic Committee commented on the latest developments in these two proceedings and, because classification ratings have to be applied to class rates, the two proceedings are necessarily tied together. The report of the Traffic Committee said that after more than three years, during which time many public hearings were held, the railroads completed what might be described as a tentative uniform classification, but in submitting it to the Interstate Commerce Commission in June of this year, it was made clear that it did not necessarily represent their views as to proper ratings because to-date they have no information about the class rate scale with which such ratings would apply. The report said the Commission was using these tentative ratings as something to start with and that it had asked the railroads and shipping public to file with it in the form of a written verified statement any objections that any railroad, any shipper or groups of shippers have to what is set forth therein. The report said such a statement would be filed for the account of the glass container industry generally by October 15th.

The Committee also reported that under the Defense Production Act enacted into law in September the President, by executive order, delegated to the Interstate Commerce Commission the authority to exercise controls over transportation in all its forms, except that by air, and that the Commission had immediately thereafter entered three control orders, the most important one being a substantial increase in freight car demurrage charges, which it said was being done to promote more prompt loading and unloading of cars.

The Committee also said the Commission now has under consideration the issuance of an order directed to the railroads, which would prohibit them from accepting carload freight unless cars are loaded to maximum carrying capacity, regardless of any tariff carload minima, but that when and if such an order is issued, an effort will be made to obtain exceptions to it, similar to those that were in effect in Office of Defense Transportation General Order 18-A in the war years.

The work of the Committee on Testing Procedures was reviewed by its Chairman, J. H. Steuernagle of the Brockway Glass Company, Inc.

The Committee on Standards for Finishes, headed by C. C. Green of the Armstrong Cork Company, reported on approved and proposed changes in drawings and advised that two prints of glass finishes and five explanatory bulletins had been issued since the last semi-annual report of May 1950.

The Committee on Container Design and Specifications, led by J. M. Foster of the Foster-Forbes Glass Company, announced revision of the drawing for the Tall One-Way Beer Bottle, Series 63, to include specifications for a 32-ounce size. It also stated that arrangements had been made to submit glass packaging specifications for honey to the Director of the Food Distribution Program Branch of the U. S. Department of Agriculture.

A Task Group appointed by the Committee has been resolving basic problems prior to reviewing specifications used by the Armed Services Medical Procurement Agency for purchasing prescription dropper bottles, tablet and capsule bottles, and powder jars.

The Committee also reported a new chart showing

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Left to right: GCMI's General Counsel Fred E. Fuller chats with President Gayner and Director of Traffic, B. H. Taylor.

THE VARIABILITY OF THE OPTICAL PROPERTIES AND THE STRUCTURE OF GLASS

By NORBERT J. KREIDL

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Limits of Validity of the Network Theory

The network theory of glass structure, according to which in oxide glasses a three-dimensional network of "glass forming" oxides is "modified" by other oxides, is an ideal simplification. It is entirely valid in a simple potassium silicate glass. The "modifying" potassium ions may migrate in the solid network of silica polyhedra if an electrical field is applied and a reserve of potassium ions is supplied. Even in the ordinary soda lime glasses which are predominantly used in all but the optical glass industries, this simplification is useful in a wide area of applications. Acidic solutions are capable of exchanging their hydrogen ions with the modifying alkali ions of such glasses.

In the great array of optical and the greater array of experimental oxide glasses this approximation suffices but rarely. Moreover, the mutual interaction of constituents of polynary systems then becomes so prevalent that a formal concept of classified constituents as well as additive relations must be limited in its application.

If calcium, even sodium, is added to the "glass forming" phosphoric acid, the vitreous structure is not weakened but fortified. Aluminum oxide is not a "glass former", still less the oxide of bivalent beryllium. Both oxides, however, fortify the glass structure.

While this effect has been well known in the case of aluminum for quite some time, a similar behavior of bivalent and monovalent ions represents the more serious contradiction to the formal function of "modifiers". K. H. Sun and A. Silverman[1] are to be credited with having first emphasized these facts when assigning the formal designation of "intermediates" to oxides which do not form glasses themselves but enhance glass formation.

This intermediate position must, however, be recognized more generally than as the property of certain oxides assuming it frequently. There is a continuous transition in the participation of elementary constituents in the structure of oxide glasses which thus does not only depend on their own kind but also on the kind and concentration of other constituents, pressure, temperature, and, in certain ranges of temperature, on time.

For instance, lithium may be characterized a "modifier", breaking up the vitreous structure, at low concentrations, high temperature, or in the quenched glass; while for high concentrations, low temperatures or upon fine annealing, the high field strength of the monovalent, but "small' lithium ion asserts itself so strongly in the bonding of neighboring oxygen that the experimental results are more in accord with those observed when "glass forming" silica is added.

The formal network theory should insist that at the ratio 40:Si the addition of modifiers prevents glass formation. Ca_2SiO_4, for instance, is said to form a glass because the $(SiO_4)^{4-}$ group is completely isolated from other such groups by calcium ions located near the oxygen corners. Experimentally, however, at least one significant exception was observed: the system $PbO\text{-}SiO_2$, in which Pb_2SiO_4 can be obtained in the vitreous condition.

The present paper describes the evaluation of the molar refraction as a measure of bonding conditions in glass and illuminates the transition in the parts played by various constituents. The parts of lead, as well as thallium and bismuth, with their high molar refractions are ascribed to the decisive influence of the particular electronic structure of these ions characterized by a positive charge relatively low in comparison to their effect. The assymetry of the electronic configuration of these ions in oxygen surroundings contributes to their inclination to participate in vitreous structures. An assymetry of this sort is also considered a contributory function in the glass formation by the glass formers proper, at the other (low refraction) terminus of the transition.

The molar refraction, and, therefore, the electronic configuration and bonding type, are found dependent upon time under certain conditions.

The Apparent Refraction of Oxygen

K. Fajans and the author[2] have investigated the apparent molar refraction of oxygen as a measure of the field strength of the cations in its neighborhood. The method is based upon the extensive work of Fajans and his collaborators[3] which comprise many substances. Later, E. Kordes[4] obtained beautiful results when applying the method to glass. He recognized that oxygen could by no means be characterized by an additive increment of refraction. He accounted for this fact by the distinction in glass of at least two types of oxygen (1) O between 2 Si, (2) O between Si and modifying elements M. Assuming for (1) the value observed in quartz, he determined (2).

The x-ray analysis of most substances, however, leaves little doubt that the distribution of distances and bonding conditions in silicates is much too varigated to be satis-

TABLE 1

Example of the Evaluation of the Apparent Refraction (cm^3/mole) of Oxygen in Vitreous Magnesium Metasilicate ($MgSiO_3$)

1. Density, 25°C., calc. to 4°C.	—	2.758	
2. V = M/d, Molar Volume	—	36.40	
3. Refractive index (*)	—	1.580	
4. Molar Refraction (**) $\frac{n^2-1}{n^2+2}\cdot\frac{M}{d}$	—	12.11	
5. Refraction of gaseous Mg^{2+}	—	.26	—
6. Refraction of gaseous Si^{4+}	—	.12	—
7. Apparent Refraction of three O^{2-}	—	11.73	:3
8. Apparent Refraction of one O^{2-}	—	3.91	

*In anisotropic materials n was evaluated as $\sqrt[3]{\alpha\beta\gamma}$ or $\sqrt[3]{\omega^2\varepsilon}$ if α, β, γ; ω, ε are indices of bi- and monoaxial crystals.

**The Lorentz-Lorenz formula was preferred because it supplied the best gradation whenever other independent considerations were available.

Translation from Acta Physica Austriaca, 3 (4) 405-417 1949.

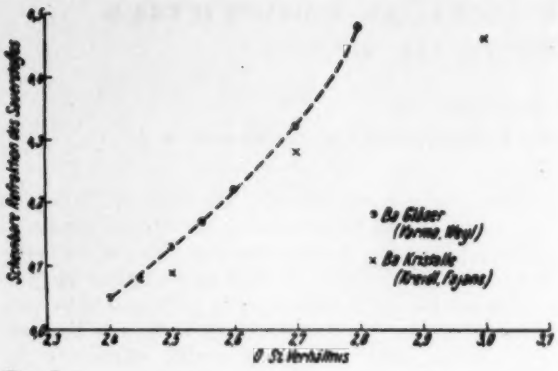


Fig. 1.

fied with the consideration of a dual role in the present investigation. It was preferred to evaluate an average value. The details of the method are described in the above mentioned publication with K. Fajans[2] and summarized in Table 1 in which a calculation is carried out. The small refraction increments of gaseous cations are assumed as constant and deducted from the experimental values of the compound to determine the apparent values for oxygen.

The Influence of Noble Gas Ions in Silicates

The numerical results of Table 2 can be summarized verbally as follows:

TABLE 2

Apparent Molar Refractions of Oxygen in Silicates of Various Cations, According to Fajans and Kreidl[2]

Cation	Metasilicates Crystal	Glass	Orthosilicates Crystal	Remarks
Be	—	—	3.35	
Si	—	—	3.52	from $SiSiO_4 = SiO_2$
Al	—	—	3.75	from complex silicates
Mg	3.73	3.91	3.83	
Li	3.97	3.97	4.5	from complex silicates
Ca	4.19	4.21	4.53	
Na	—	4.45	4.5	from complex silicates
Sr	4.29	4.60	4.67	
Ba	4.46	—	4.97	

(a) The apparent refraction of oxygen in silicates is not constant, but very variable.

(b) It is nearly always noticeably greater in glasses than crystals.

(c) It increases, as one progresses from the "small" Be to the large "Ba". If this is interpreted as the influence of the effective field strength of the cations upon the electrons in oxygens a series comparing equivalent amounts (e.g. ½ Si, 1 Ca, ⅔ Al, 2 K) can be worked out as given in Table 3.

As silicon is incorporated in the series, it becomes evident that the effect of aluminum is nearly as great as that of silicon, and that of beryllium even greater. This contributes to the intermediate position of these elements in the classical network theory. Since silicon decreases the apparent molar refraction of oxygen much, while barium occupies the other end point of the series, one should expect a great increase of the refraction with decreasing silicon content, i.e. increasing O:Si ratio in the series SiO_2-Ba_2SiO_4.

This relation is verified in Table 4.

TABLE 4

The Apparent Molar Refraction of Oxygen and the O:Si Ratio in Barium Silicates

Formula	O:Si	Crystal	Glass
SiO_2	2	3.52	3.65
$Ba_2Si_2O_5$	2.5	4.09	—
$Ba_2Si_3O_8$	2.66	4.28	—
$BaSiO_3$	3.0	4.46	5.5
$BaSiO_4$	4.0	4.97	—

The comparison of other silicates shows that this increase of the apparent refraction of oxygen with the increasing O:Si ratio ("basicity") is general if the cation follows silicon in the series of increasing refractions. The effect is small for aluminum and reversed for beryllium which precedes silicon in the series.

It should be noted that barium is so "large" and its refraction so comparable to that of oxygen that the premises of the method are no longer strictly valid. The high refraction calculated by oxygen is in part caused by a deformation of barium which can no longer be neglected. Nevertheless the increased refraction in the entire system is interpreted as electronic loosening and presents the barium silicate as a transition to the lead silicates for which, however, no more attempt of a separate evaluation of oxygen was made.

Varma and Weyl[6] applied the method to barium glasses of various composition. In Fig. 1 their series of refraction as a function of O:Si ratios is compared to some evaluations of the author on crystals.

Borates, Phosphates and Borosilicates

The viewpoint here presented does not permit a strict separation of glassforming and modifying cations. The Anion complexes of some crystals have been compared

TABLE 3

Order of Cations in Decreasing Effective Field Strength as Evaluated from Increasing Apparent Refractions of Oxygen in Orthosilicates

In some cases the position in the table was interpolated from the metasilicate series.

Cations:	$2Be^{2+}$	Si^{4+}	$4/3Al^{3+}$	$2Mg^{2+}$	$4Li^{+}$	$2Ca^{2+}$	$4Na^{+}$	$2Sr^{2+}$	$4K^{+}$	$2Ba^{2+}$
Apparent O^{2-} Refractions:	3.35	3.6	3.75	3.83	—	4.53	—	4.67	—	4.97

by Fajans, and the complexes of some morate and phosphate glasses were investigated by Jones and Kreidl[6a].

Fajan's series of anions is presented in Table 5.

TABLE 5

Apparent Molar Refractions of Oxygen in Crystallized Salts $R^{n+}(XO_4)^{n-}$

	Equivalent Amounts of the Cation			
With the Anion	Ca	Sr	Ba	K
$(SiO_4)^{4-}$	4.53	4.67	4.97	—
$(PO_4)^{3-}$	3.79	—	—	—
$(SO_4)^{2-}$	3.5	3.41	3.50	3.60
$(ClO_4)^{-}$	—	—	—	3.26

For the same oxygen ratio the apparent refraction is smaller the greater the yield strength of the cation becomes in terms of the valency, i.e. decreasing from boron to chlorine in the series B^{3+}, Si^{4+}, P^{5+}, S^{6+}, Cl^{7+}.

The borates are represented in Table 6.

TABLE 6

Apparent Molar Refraction of Oxygen in Borates

	Cation				
Ratio O:B	2H	2/3B	Mg	Ca	2Na
1.5	3.30	3.37			
1.75					3.53
2				3.86	3.88
3			3.79		

The values are smaller than in the silicates described before, although B^{3+} is weaker than Si^{4+}. The reason is the frequency of smaller values in borates due to its low valency. Conversely, the phosphates of Table 7 have generally large refractions of oxygen because of the high O:P ratios found in the studied compounds of pentavalent phosphorus.

TABLE 7

Apparent Molar Refraction of Oxygen in Phosphates

Equivalent Cation: O:P Ratio	Be	B	Al	Y	Mg	Ca	Na
3.5	—	—	—	—	3.48	—	—
4	3.0	3.19	3.57	3.68	—	3.8	3.9
4.5	—	—	—	—	—	4.22	—

Only if, as in Table 5, equal O:B, O:Si and O:P ratios are compared, are the values decreasing from B over Si to P.

In borosilicates, where the addition of B_2O_3 often increases* the O:Si+B ratio, lower* refractions will accompany the strengthening of the vitreous structure. Here, however, the coordination of boron must be noted the change of which caused minima of refraction to be observed in the pure magnesium and barium borate glasses studied by Varma and Weyl[5] (Fig. 2) at an O:B ratio of 1.65.

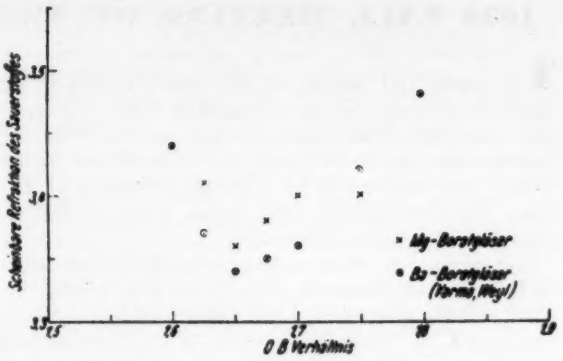


Fig. 2.

Lead Glasses

In the case of lead glasses new viewpoints are required for the analysis and solution of the problem of their existence and nature.

The evaluation of an apparent molar refraction of oxygen did not seem permissible[2] since the experience gained with other lead compounds indicated larger molar refractions for divalent lead than for oxygen. In the field of variable anionic environments the refraction of lead may thus vary as much as that of oxygen in cationic environments. Without any doubt, however, this very condition characterizes the considerable loosening of the electronic system of divalent lead as a particularity of its compounds.

Therefore, the assymetry connected with this looseness was postulated to be an accessory condition of glass formation.[2] The assymetry was explained on the basis of the peculiar electronic structure of divalent lead and demonstrated by the X-ray analysis of crystalline lead oxide. The experiments of earlier and newer investigators of the silicates and borates of thallium and bismuth appear to substantiate a similar effect of their similar electronic structures[7].

The divalent lead ion Pb^{2+}, as well as Tl^{+} and Bi^{3+}, have two external ($6s^2$) electrons outside of their closed 18 electron shells.† These electrons may be considered more displaceable than those in a closed 18 electron shell, and much more than those in a closed 8 electron shell of an ordinary "modifier" when approached by the negative field of oxygen.

In the x-ray analysis of PbO the net result is the extraordinary assymetry of the distances of the lead nucleus from its oxygen neighbors. Four oxygen nuclei are at the distance of 2.3, four others at the distance of 4.3 angstrom units. [8,9] Recently K. H. Sun discovered a new family of optical glasses[10] in which a relative small amount of the glass forming BeF_2 was stabilized by large amounts of PbF_4.‡

Possibly, this assymetry of the electronic arrangements contributes essentially to glass formation not only in the extreme case of the compounds of elements having so deformable shells, but also in the case of the classical glass formers proper. In those compounds oxygen must have the low coordination of 2 and its electron shell will be greatly deformed.

The series of refractions discussed in the present paper

(*Continued on page* 598)

*Error in German text which was "higher".

†The German text erroneously misquotes the original paper by K. Fajans and N. Kreidl, speaking of 1, 2, 3 outer electrons instead of two remaining after the loss of 1, 2, 3 outer electrons. This error will be corrected in an erratum (Transl.).

‡Error in German text: BbF_2.

1950 FALL MEETING OF THE GLASS DIVISION IN TOLEDO

The annual fall meeting of the Glass Division of the American Ceramic Society was held in Toledo, Ohio, at the Commodore Perry Hotel, October 6 and 7, 1950. The considerable interest in Toledo as "Glass Center of the World" was responsible for a record attendance of 230 Glass Division members, the largest group so far on record as attending a fall meeting.

The mechanism of the meeting was efficiently handled by C. S. Pearce, Secretary of the American Ceramic Society, and his co-workers, L. G. Farber, Technical Secretary, and L. E. Ohrstedt. Members of the Northwestern Ohio Section of the Society were responsible for many arrangements, and Harry H. Holscher, Chairman of the Glass Division, and F. G. Schwalbe, Chairman of the Local Committee, were responsible for the good direction which made the meeting a success.

The City of Toledo had delivered several prime broadsides to prove its stature as a glass town, and make available to the visitors its wealth of glass art and science. Mr. Grove Patterson, Editor-in-Chief of the *Toledo Blade*, featured two editorials on glass in the few days before the meeting. The Chamber of Commerce and Convention and Visitors' Bureau cooperated closely with the local committee. The Toledo Museum of Art made available two conducted tours so that visitors could view the most comprehensive collection of historical and art glass in the world. The Toledo Public Library invited visitors. Its famous murals are probably the most unique of their kind in the country. Also, a special window display of glass products was arranged in the library window, in which the four major glass manufacturing companies and several glasshouse supply concerns of Toledo were represented.

Despite the temptation to take advantage of the comfortable facilities of the hotel lobby, 28 fortitudinous glassmen early Friday morning took advantage of sunny October weather and participated in a golf tournament held at the Highland Meadows Golf Club, Sylvania, Ohio. Robert M. Curts did his usual good job as Chairman of the golf committee, with J. C. Coleman acting as local Chairman, assisted by A. H. Couch. Prizes were donated by the following suppliers: Cohart Refractories Co., B. F. Drakefeld & Co., Foote Mineral Company, Niagara Alkali Company, THE GLASS INDUSTRY, Pacific Coast Borax Co., Pemco Corporation, Stauffer Chemical Company, American Potash & Chemical Corp., R. T. Vanderbilt Co., Walsh Refractory Co., Willson Products Company, National Lime & Stone Co., Central Silica Co., Dominion Minerals Inc., Innis, Speiden & Co. and Woodville Lime Products Co.

Mr. Ken Henry turned in the low gross and, once again, won the Oscar Hommel trophy. Prize winners were Messrs. Stuntz, Simpson, Pinotti, Ellis, Curts, Crowell, Huot, Wisby, Burch, Moffat, Dudley Smith, Pavlish, Glynn, and Poole. One prize was allocated as a door prize for non-golfers—Mark P. Jeffries won it—and another was awarded to Jim Coleman in appreciation of his "all out" efforts which made the tournament a great success.

An unusually interesting program of technical papers had been prepared by a program committee consisting of W. T. Gray, Leeds and Northrup Company, Philadelphia, acting as Chairman, and K. B. McAlpine, Pittsburgh Plate Glass Co., and W. H. Manring, Ball Brothers Co. The technical session was begun Friday afternoon in the Crystal Room of the Commodore Perry Hotel, while the attending ladies were escorted on a tour through the famed Toledo Museum of Art.

Chairmen of the first session were H. H. Holscher and F. V. Tooley. The first paper presented was read by R. E. Mould, Preston Laboratories, Butler, Penna., on the subject of "New Techniques for the Measurement of Transient Stresses in Bottles Under Impact".

Bonded wire strain gages and auxiliary electronic equipment were used to measure the stresses produced by impacts on glass bottles. Magnitude and distribution of stress on both inside and outside surfaces also were studied. Duration of impact and dynamic behavior of the bottle were determined from photographs of oscilloscope traces. The technique of mounting the strain gages was described.

Maximum impact stress is located on the inner surface of the bottle directly under the point of impact. For moderate impacts this stress is as high as 50,000 psi. and an undamaged inner surface will withstand much higher stresses than this. A typical impact has a duration of about .001 sec. and takes the form of a single pulse with resonant vibrations of the bottle relatively unimportant.

A second paper, describing work of the Preston Laboratories, was presented by H. M. Dimmick. It was titled, "Discussion of a New Type Hydrostatic Pressure Tester for Bottles".

A tester which automatically increases the internal pressure in a bottle until breakage occurs was described. The pressure is increased stepwise in 20 or 40 psi. increments depending on the type of bottle under test. The value of the pressure and the time the bottle is held at each pressure level are controlled electronically.

The average time required to take a bottle to failure is less than a minute so that with this machine it becomes practical to make statistical studies of the quality of ware in production.

This is the machine recently described by Dr. Preston in the THE GLASS INDUSTRY as having been nicknamed the "Pinball Machine" by some glass technologists because of its flashing lights. Judging by Mr. Dimmick's remarks, the machine is just as colorful and much more useful than its namesake.

The "Variation with Temperature, of the Cracking Velocity of Glass" by H. M. Dimmick and J. M. McCormick was also presented by Mr. Dimmick.

The limiting velocity of fracture for a soda-lime glass was measured as a function of temperature over the range of 80°K and 475°K. The value of the fracture velocity was obtained by electronically measuring the time necessary for the crack to travel between two platinum lines fired into the surface of the glass specimen. The value of the fracture velocity for this glass was found to be 1485 m/sec at 300°K with the velocity decreasing slightly with increasing temperature over the range studied. The results indicate a temperature co-efficient on the order of –0.15 m/sec/°K.

A "Method of Measuring Surface Durability of Glass" was presented by Dr. H. E. Simpson, New York State College of Ceramics, Alfred, N. Y. The work was done on flat glass.

Glass samples about 3″ square were exposed to alternate cycles of fogging and clearing on their surfaces. The cycling operation consisted of a temperature drop from 55°C. to

about 50°C. and a rapid recovery to 55°C., the humidity surrounding the samples being maintained constantly at 100%. The total transmission of the sample and the amount of scattered light were measured by means of a photoelectric cell and the relative amount of scattering was taken as a measure of the amount of haze or surface deterioration. It was found that when the percent haze was plotted against time of exposure, characeristic curves were produced for different types of glass. Details of sample preparation were found to be very important. Data on several types of glass were presented.

The author expressed his appreciation to the members of the Research Staff of Libbey-Owens-Ford with whom he collaborated in this research.

The paper was well received, and regarded as a sound approach to the problem. In an ensuing discussion, Dr. Preston related some of his experience with surface durability measurement and stated that some glasses he studied exhibited surface hazing when exposed to moist air, but were not attacked after complete submergence in water for a long period of time. From this he concluded that Libbey-Owens-Ford might find a surface-protecting wareroom at the bottom of Lake Erie. It has since been reported that the L-O-F people took this under advisement, but decided against any such action because some of the glass might become fractured, and they had no desire to cut into the Lake Erie fishing industry.

A very comprehensive approach toward correlation of the changes in the physical properties of glass between the rigid and softened states was made by J. V. Fitzgerald, Pittsburgh Plate Glass Company. His paper has been abstracted as follows:

A variety of well-known but so-called anomalous and peculiar properties of glass can be better understood if reference is made to the generalized theory of anelasticity which has been applied with great success to the better understanding of the metallic state by C. Zener and his colleagues of the Institute for Metals of the University of Chicago. For example the secular rise of the ice point, room temperature elastic after-effects exhibited by loaded glass rods, dimensional changes known to occur in astronomical mirrors, room temperature relaxation of the shear modulus, variation of torsional internal friction peaks with temperature and frequency, internal friction of rods in transverse vibration and the anomalous electrical absorption and discharge current are manifestations of the same physical phenomenon but observed under different experimental conditions.

This phenomenon which is shown to be associated very closely with ion diffusion was conveniently studied by determining the internal friction of glass fibers in torsional vibration as a function of period of vibration and temperature. Other processes such as the effect of viscous flow on the elasticity, the elastico-viscous effect discussed by N. W. Taylor, the precipitation of crystalline phases in the vitreous matrix as well as the change in state brought about by annealing can also be investigated by this technique. Not only the internal friction, but also the shear modulus and activation energy for the process can be determined. All these various anelastic phenomena observed in glass can be represented schematically in the form of an acoustic spectrum similar to that given by Zener for metals. To quote from Zener's book, Elasticity and Anelasticity of Metals: "It seems likely that the acoustic spectrum will come to occupy a position in solid-state studies comparable to that possessed by the optical spectrum in the theory of atomic and molecular structure."

To conclude the Friday session, a paper titled "Density and Thermal History of Glass" by N. J. Kreidl and R. Weidel, Bausch and Lomb Optical Company, Rochester, N. Y., was read by Mr. Weidel.

It was found that the density of a 517:645 optical borosilicate glass increased by more than 1% when samples quenched from the highest temperature, at which no further decreases in density were observed, were annealed at the lowest temperature, at which increases were observed within reasonable time. Conversely, stabilization times increased with decrease of stabilization temperature. This behavior was in agreement with that exhibited by this and other glasses in respect to other properties. The increase in density caused a much smaller increase in refractive index than expected from conventional refraction density relations. This was interpreted to mean that in glasses packed to a high density, the molar refraction decreased in relation to a tightening of the electronic structure.

It may then be said that the refractive index of a fine annealed glass was the result of two opposing trends: the increasing density would increase it, the decreasing molor refraction indicative of a tight and less responsive electronic system would decrease it. The net result is the moderate increase observed in previous studies.

The traditional banquet on Friday evening was a gay and noble affair, punctuated by admirations for many acknowledged accomplishments and great hilarity for various and sundry witticisms. After a sumptuous dinner, topped off by huge islands of Baked Alaska floating around to each table, able toastmaster Harry Holscher introduced the honored guests at the speakers' table.

These included J. W. Hepplewhite, President of American Ceramic Society; H. R. Lillie, President-Elect; A. K. Lyle, Vice President; W. E. Cramer, Treasurer; and C. S. Pearce, Secretary. Also, the officers of the Glass Division; K. C. Lyon, Trustee; C. E. Leberknight, Vice-Chairman; and F. V. Tooley, Secretary. Also, F. G. Schwalbe; K. C. Carnes, Chairman, N. W. Ohio Section, A. C. S.; Robert M. Curts, S. D. Stookey, James P. Poole, and Allen Saunders, Speaker of the evening.

K. C. Lyon presented the Frank Forrest award to James P. Poole for outstanding research work recently completed on viscosity measurement apparatus. Mr. Poole is Director of Research at Brockway Glass Co., Brockway, Pa. The S. B. Meyer award was presented to S. D. Stookey, Corning Glass Works, for his work on the development of photosensitive glass. A. E. Badger and N. J. Kreidl acted as scrutineers in the selection of these awardees.

A ceremonial presentation of a glass "Key to Toledo" was made by K. C. Carnes to J. W. Hepplewhite, who accepted it on behalf of the American Ceramic Society. This key will be displayed at ACS Headquarters in Columbus, along with other Society trophies, in commemoration of the 1950 Fall Meeting.

F. G. Schwalbe introduced Allen Saunders, Toledoan and author of the nationally syndicated comic strips, "Steve Roper" and "Mary Worth". Mr. Saunders' talk, "The Philosophy of Humor", was a series of engaging stories built around an effective scientific formula. See anyone who attended the Fall Meeting for a full explanation of all terms of the formula.

Toastmaster Holscher rounded out the program by introducing the following members of the Local General Committee: R. K. Day, F. C. Raggon, and L. W. Dittlebeck, and the Local Publicity Committee: J. Gilbert Mohr and H. L. Miller.

The Saturday morning technical session convened at 9:00 A.M. with C. E. Leberknight of Kopp Glass Co. as Chairman. The paper, "Change of the Iron Color in Glass with Annealing Temperature and Time" by N. J. Kreidl and T. G. Pett, Bausch and Lomb Optical Com-

pany, was not presented due to the illness of Mr. Pett.

The paper, "Slow Neutron-Absorbing Glass", was delivered by Laben Melnick of the University of Pittsburgh. His co-workers were Hurd W. Safford, Kuan-Han Sun, and Alexander Silverman.

The theory, compositions, and testing methods were generally described. The most successful neutron-absorbing glasses were found in the ternary composition diagram SiO_2-B_2O_3-CdO, with constant CaF_2 and minor Al_2O_3 additions. The ratio of the neutron-absorbing properties of the glasses with respect to cadmium metal was used as a method of evaluation of the experimental data, and comparison with soda-lime and x-ray absorbing glasses was made.

"The Effect of Composition and Temperature on the Specific Heat of Glass" was presented by L. B. Ginther, Libbey-Owens-Ford Glass Company, Toledo, Ohio. D. E. Sharp was co-author.

Clarification was made of the method of calculation of the specific heat of glass from the composition factors. Published data on the effect of composition, temperature, crystallization, and history on the specific heat of glass were reviewed. Various equations that have been used for expressing specific heat as a function of temperature were discussed, and the equation

$$Cm = \frac{at + Co}{0.00146t + 1}$$

was proposed as a simple and reasonably accurate expression which is adaptable to an additive relationship to composition. Factors were furnished for use in this equation by means of which the mean or true specific heat may be calculated from the composition over broad temperature ranges with an accuracy adequate for most engineering purposes.

The report of a "Method for the Measurement of Thermal Diffusivity" by A. F. Van Zee and C. L. Babcock, Owens-Illinois Glass Company, Toledo, Ohio, was made by Mr. Van Zee.

Thermal diffusivity data were obtained on two typical soda-lime-silica glasses in the temperature range from 1200°F. to 2600°F. The thermal diffusivity of a typical glass increased exponentially from 0.014 at 1200°F. to 0.24 cm^2 per second at 2600°F. The measurement gave the total heat transferred by both conduction and radiation.

The glass sample was held in a long crucible having cylindrical symmetry. A small sinusoidal temperature variation was superimposed on the mean temperature of the sample and the time-lag for the sinusoidal heat wave to travel radially from a point on the circumference of the sample to the center was measured.

Furnace construction, method of controlling sinusoidal heat input, and methods of measurement were described.

To conclude the technical program, a paper on "Surface Tensions of Binary Alkali Silicates", by L. Shartsis and S. Spinner, was read by Mr. Shartsis.

The surface tensions of molten compositions in the systems Li_2O-SiO_2, Na_2O-SiO_2 and K_2O-SiO_2 have been measured with a maximum pull-on-cylinder method. Lithia increased the surface tension more than soda. Potash lowered the surface tension. With increasing amounts of alkali, the temperature coefficient of surface tension became more negative. The negativity of the temperature coefficient of surface tension showed a positive correlation with expensivity in the liquid range.

As Howard Lillie had promised, he showed to the group pictures taken during his recent travels through England, France, and Switzerland. The occasion which prompted Mr. Lillie's trip was his acting as a delegate to the International Glass Commission held at Bern, Switzerland, on July 10 and 11, 1950. His pictures included some taken of the buildings of the Society of Glass Technology, University of Sheffield.

At a short business meeting conducted by the members of the Glass Division, Secretary Tooley read the minutes of the last meeting. These included description of a citation sent to Dr. Heinrich Maurach on the occasion of his 70th birthday, and commending him for his contributions of glass research. Mr. Lillie then gave a brief report of his trip, and reported that the Board of Trustees of the American Ceramic Society had approved participation and permanent membership for the Glass Division in the International Glass Commission. Howard R. Swift reported that the New York State College of Ceramics had agreed to take over the work of the production of Experimental and Calibration Glasses. The meeting was adjourned, and thus ended a very successful Fall Meeting.

The end of the meeting posed one question, however. Since there are about 750 men listed as members of the Glass Division, why is it that not more than about 200 take advantage of the technical and programming work upon which so much effort is well spent each year?

A.C.S. SECTION MEETINGS

The Pittsburgh Section of the American Ceramic Society held its annual joint meeting with the Pennsylvania Ceramics Association on November 14 in the Mellon Institute auditorium. Preceding the meeting, dinner was served at the Royal York Apartments Hotel. The program was under the direction of Dr. E. C. Henry, Pennsylvania State College, and included a report on the ceramic activities at Penn State, as well as supporting activities of the Association. Technical papers were presented by members of the College's faculty.

The Pittsburgh Section's December meeting will feature the presence of the President of the Society, J. W. Hepplewhite, who will be speaker of the evening. President Hepplewhite will discuss the activities of the national society and will also give a talk on whitewares.

The Trenton Section of the A.C.S. was attended by eighty members and guests at its first meeting of the fall season. Following the business meeting, the evening was devoted to a talk given by Dilman Smith, Vice President of Opinion Research. Mr. Smith's talk dealt with recent trends in employee thinking. Using the results of many opinion surveys, Mr. Smith pointed out the public's opinion on the major domestic issues arising from the Korean War and also on how management could implement its free enterprise position in the light of recent trends in employee thinking.

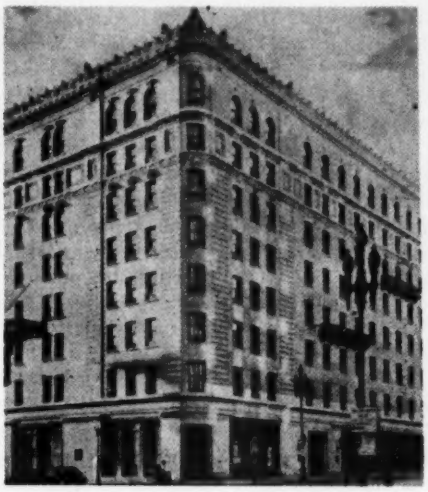
VICE PRESIDENT NAMED BY STEUBEN GLASS

Steuben Glass, Inc., has appointed J. Beacham Tredennick as Vice President, it has been announced by Arthur A. Houghton, Jr., President.

Mr. Tredennick joined the company in 1938. Formerly, he was with the Northeastern Construction Company.

DIVERSIFIED GLASS PROGRAM AT PACIFIC COAST REGIONAL MEETING

Industry support of the October San Francisco regional meeting of the American Ceramic Society was evidenced by an attendance that far exceeded expectations. The registration of somewhat over 390, together with the interest exhibited by members of the convention, testifies to the value of these meetings to the West Coast ceramic industries. The pattern of the last two regional meetings, highly praised by eastern visitors, was characterized by liberal discussion of papers and by the unconventionality of the entire program. The combined committees are to be complimented on their attention to the details and to the smooth functioning of the program.



75-year-old Palace Hotel.

The Palace Hotel where the regional meeting was held is an historic landmark in San Francisco. On October 20 it celebrated its 75th anniversary, during which period it catered to pioneers of all industries in that area of California and is therefore saturated with the spirit and traditions of western pioneer days.

The program for the glass session was well balanced in that theory was combined with practice. Chairman for the opening session, Wendel A. Mahaffy, of the Owens-Illinois Glass Company, introduced Jim Tomlinson of the Pacific Coast Division of the Owens-Corning Fiberglas Corporation who reviewed the extent to which fiber glass is being used on the West Coast. He supported his talk with a liberal display of samples, and the popular demonstration of baking cookies in the same cooker in which ice cream was stored. The variety of uses to which fiber glass can be put, as in the form of mats, fabrics, and laminates, explains its wide acceptance by diversified industries. Research and development indicate many more applications of this very versatile material.

The second paper reviewed sand processing operations by the Del Monte Products Company and made reference to experimental work in progress on the separation of feldspar. Inasmuch as the Del Monte Sand is widely used in the San Francisco area and is also used in considerable amounts in the Los Angeles area, "Pete's" presentation was of timely interest in all glass manufacturers on the West Coast.

T. K. Cleveland of the Philadelphia Quartz Company discussed soluble silicates with particular reference to the problems of raw materials and manufacture. Manufacturers of sodium silicate have problems of refractory life very much paralleled to those of the glass industry and in many respects, are more critical. The viscosity of the product is subject to careful control and the applications of the various brands to industry are well diversified.

Victor C. Swicker of Alexander H. Kerr & So., Inc., discussed common types of cords with reference to the extent to which they affect the strength of a container. Methods for diagnosing and examining cords were briefly mentioned as well as typical case histories. In the discussion that followed, a representative of one of the West Coast factories described a cord problem being faced at the moment with reference to the cause of the trouble and the effect on the glass. Much of the discussion revolved around this case.

The session Friday morning, October 20, combined both the glass and refractories section. Victor C. Swicker acted as Chairman. James C. Hicks of Kaiser Aluminum and Chemical Corporation of San Jose discussed refractories in glass factory regenerators with particular reference to the penetration of corrosive materials. Numerous slides showing depth of penetration in the body structure were discussed, together with the effect on serviceability of the product. The discussion that followed included the effect of steam and reducing conditions on basic materials and the desirability of using the same type material in the super structure. This particular subject was of immediate interest to everybody present as this is a problem common to all glass manufacturers.

A great deal of interest was shown in the paper entitled "Use and Misuse of High Alumina Fused Cast Refractories" which was presented by O. R. Stack of the Carborundum Company. The gradual expanded use of this type of sidewall material points to the increased acceptance by industry. This paper was supported by numerous slides and was followed by considerable discussion. The application of two-course sidewall construction was commented on as well as the practice of "balancing" the sidewall structure. Reference was made to the effect of chromium oxide on the color of the glass, and quantitative limits were discussed.

W. D. Smiley of Stanford Research Institute presented a talk entitled "Application of Phase Equilibrium Diagrams to Reaction between Refractories and Glass". Dr. Smiley started off with the use of diagrams for two component systems, and proceeded to three component diagrams, making reference to the necessity for utilizing four component diagrams in order to arrive at a more precise knowledge of glassmaking operations. Comments regarding this paper indicated the need for more fundamental talks of this nature.

Ted Pryor of Pryor Giggey Company discussed tests in progress dealing with the measurement of thermal shock resistance for certain refractory bodies. The testing apparatus was described, together with the results of certain tests on typical materials.

The final presentation consisted in showing the action of glass on refractories by means of a moving picture technique developed by Henry N. Boumann of the Carborundum Company. The audience showed very much

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GLASSMEN REPORT PROGRESS IN ACCIDENT PREVENTION

Systematic accident prevention programs are paying rich dividends in the plants of Pittsburgh Plate Glass Company and the Owens-Illinois Glass Company. This was the word brought to the meeting of the National Safety Council's Glass and Ceramic Sections during the National Safety Congress in Chicago, October 16 to 20.

Outlining the safety program in effect in Pittsburgh Plate Glass plants, D. W. Gibson, Safety Supervisor of the firm's Columbia Chemicals Division, Barberton, Ohio, said that when the present program was adopted in 1948, the frequency rate was 12 disabling injuries per million man-hours of employment. Last year it dropped to 1.35 and thus far in 1950, he said, it is holding at approximately the same level.

Experiences at the Owens-Illinois Glass Company plants were reported by Earl F. Schaefer of the general engineering department, Alton, Illinois, who said that last year in the Glass Container Division his company boasted an accident frequency rate of only 1.6 per million man-hours. This, he pointed out, compares quite favorably with a frequency rate of 7.98 for the entire glass industry and even more favorably with the 10.14 frequency rate for all industry, as tabulated by the National Safety Council.

These encouraging figures seem to justify the assertion of the Section's General Chairman, John P. Stephenson, Safety Director of Ball Bros. Company, Inc., who, in his remarks opening the conference, declared that work of the Glass and Ceramics Section in promoting safety is beginning to pay off. While growth in interest has been slow, it is increasing steadily, Mr. Stephenson said, and accomplishments to date give assurance that even greater accomplishments can be anticipated in the future. He pointed out that, through work of the various committees of the Section, the industry is enabled to obtain material on many aspects of safety not available through other services.

Although the Section's meeting during the roundup of safety authorities in Chicago were limited to two afternoon sessions of 2½ hours each, a great deal of ground was covered, especially in the discussion periods and, in the free exchange of experiences, much was accomplished in promoting the cause of accident prevention in the industry.

The first formal paper on the program was presented by R. F. Graef, chief engineer of the H. K. Ferguson Company, whose business is the designing of industrial buildings of all types. In announcing his topic, "Controlling Accidents Through Engineering Design and Layout", Chairman Stephenson remarked that it was a highly appropriate subject for consideration by an industry which, when expansion is in order, is notorious for adding "just one shed after another".

Plunging into his discussion, Mr. Graef said that in preparing plans for new industrial structures, his company's engineers view the problem of safety from two standpoints—safety to the employee and safety to the equipment. Each piece of equipment going into a new plant, he explained, is reviewed by a group of specialists to determine all possible hazards and to make any adjustments indicated to prevent accidents.

It is essential, he continued, to provide adequate working space around all machines and, while extra floor space may increase building costs, the failure to make the machine easily accessible may prove to be an expensive error.

In planning the layout, he went on, the designer must be familiar with processes and equipment, since the handicaps of poor arrangements can never be overcome. Attention must be given to the use of materials handling equipment at every possible point, not only because this reduces manpower and speeds up operations, but because the very fact that fewer men are required will also reduce the possibility of accident to workers. In the long run, he declared, the maximum utilization of handling equipment will be justified in practically every case.

Reviewing other hazards in present day glass plants, Mr. Graef said one of the greatest is the oil used to spray molds. Since this will fall on dust accumulations, the designer of new glass plants must give thought to reducing the ledges, corners, and other exposed surfaces around presses, etc., where dust could pile up. He spoke also of the importance of ventilating systems to collect fumes at point of origin; provisions for adequate headroom to avoid accidents or collision; railings on walkways; guards on machines; proper drainage for water that might collect in pools on floors; and other conditions or situations that might affect the safety of the worker.

In a symposium on "Combating the Causes of Accidents", Mr. Gibson of Columbia Chemicals told of the foremanship training program which has been effective in reducing accident frequency rates among Pittsburgh Plate Glass plants, as mentioned earlier. Briefly this program has seven points, as follows: (1) Schooling the foreman in a safety course; (2) requiring them to make personal contact with each worker several times a week on some safety subject; (3) requiring them to make a regular comprehensive report on lost time injuries and near accidents; (4) requiring them to check the workers on observing safety precautions on the job; (5) placing them in charge of all safety meetings; (6) requiring them to submit suggested safety changes in writing; and (7) requiring them to instigate and write their own individual department safety pamphlets.

"Safety is an endless job," Mr. Gibson summed up. "There are still a lot of things to be done. But, in reducing the frequency rate in our plants from 12 to 1.35 in two years, we feel that we are on the right track."

W. W. Wood, Personnel Director, Kimble Glass Division of Owens-Illinois Glass Company, told how induction procedures in his company's plants are used to introduce new employees to safety the day they start.

"Safety," said Mr. Wood, "should be emphasized with the new employee so that he will start off on the right foot. It is always well to tie the individual into the safety picture by showing him just what it will cost him and his family through lost income, if he should have a disabling accident."

He outlined how new employees are welcomed by a man with 55 years' service in the company, and instructed on everything from where to find the cafeteria

(*Continued on page* 606)

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Feeding and Forming

Manufacture of Footed Stem Ware. Fig. 1. Patent No. 2,523,737. (Seven sheets of drawings.) This is an invention by Jacques Tourres of LeHavre, France.

The machine is made with four identical sections each having two roughing molds 3 and 4 which are opened and closed in the usual manner. The mold 4 has suction grooves 11 connected to vacuum. A charge of glass is delivered to the mold 3 while the bottom plate 16 is removed and after the blank is formed by a neck pin and air from below, it is transferred by one of a pair of bead molds 36 to a finishing mold 28. Air is then admitted to form the cup portion of the ware in the mold 28 after which the ware may be removed by tongs.

The machine is entirely automatic and it is capable of various modifications to form different kinds of ware. The patent has four claims and 15 references were cited by the Patent Office.

Furnaces

Electrical Melting Furnace. Fig. 2. Patent No. 2,523,030. (One sheet of drawings.) Assigned to Glass Fibers, Inc., by Dominick Labino of Maumee, Ohio.

The furnace comprises a tank 2 having a dog house 3 and burners 4, the products of combustion passing out through a stack 6. The lower part of the glass in the tank is heated by electrodes 8 located in the opposite side walls of the tank. These electrodes are made of molybdenum and water cooled. The molten glass passes out under a gate 13 in the forehearth 10 to the orifice 11. It is then made into marbles or the like if it is to be used in making glass fibers. This combination of fuel and electric heat results in a glass free from gas and the furnace has a long life.

The patent contains seven claims and 14 references were cited by the Patent Office.

Batch Feeder. Patent No. 2,525,323. (One sheet if drawings not reproduced.) Assigned to Drammens Glassverk, Drammen, Norway, by Ragnar Tanberg.

A refractory tube depends through the crown of a furnace and the batch is introduced to the tube from an overhead hopper which may be shaken to assist the feed. A valve closes the lower end of the tube when the batch is first introduced. The tube is spaced above the glass level and the heat from the furnace sinters the batch in the tube so that it enters the molten glass as a more or less solid rod.

The references cited were 1,421,210, Good, June 27, 1922; 2,114,545, Slayter, Apr. 19, 1938; and 2,294,373, Batchell, Sept. 1, 1942.

Glass Compositions

Ophthalmic Glass. Patent No. 2,523,264. No drawings. Assigned to Corning Glass Works by William H. Armistead. The invention relates particularly to glasses for making the small buttons to be sealed to spectacle lenses to make multifocal lenses.

Four examples of glasses coming under this patent

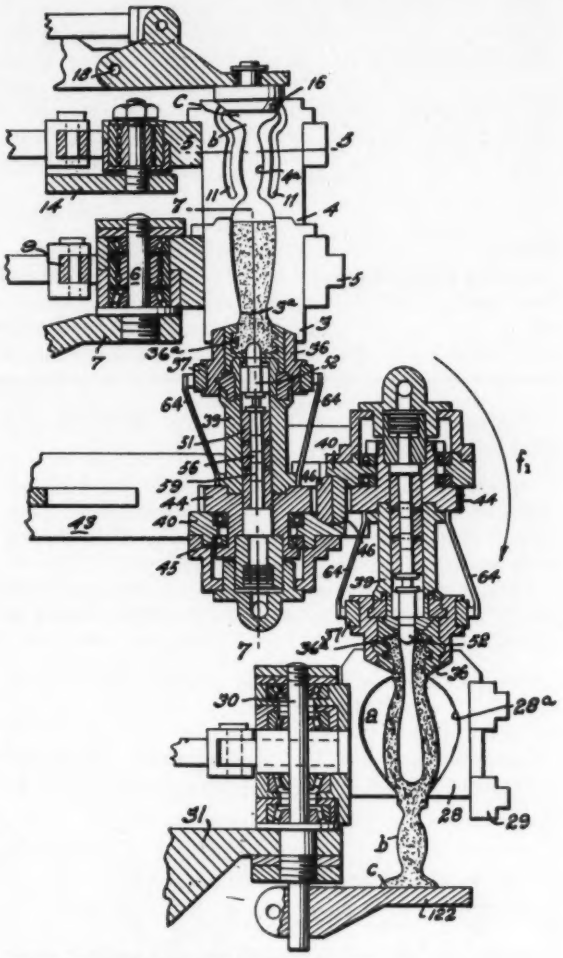


Fig. 1. Manufacture of Footed Stem Ware.

are given in the following table as calculated in weight percentage from their batches.

	1	2	3	4
SiO_2	39	39	45.5	37
B_2O_3	2	2	4	2
ZrO_2	5.5	5.5	7	8
BaO	20	20	20	20
ZnO	3	3	..	..
Li_2O	1	2	.5	1
Na_2O	4.5	3.5	9.5	5
Al_2O_3	2	2	..	2
CaO	7	7	5	10
TiO_2	4	4	2.5	..
PbO	..	..	..	5
CdO	12	12	6	10
Softening point, °C.	690	670	691	699
Exp. Coeff. $\times 10^7$	85	88	91	92
nD	1.659	1.660	1.616	1.680
ν	45.3	45.5	49.4	43.2

	1	2	3	4	5	6	7	8	9	10	11
SiO_2	43	46	40.5	46.5	52.5	47	49	39.5	43.5	44.5	39
B_2O_3	5	4	4	4	4	5	2	5	4	4	3
ZrO_2	7	7	6	7	3	10	10	7	7.5	7	7
BaO	20	20	20	20	20	....	6	20	23.5	23.5	20
CaO	5	5	10	5	....	10	5	5	5	8	5
ZnO	....	....	10	7.5	7.5	12	12	7.5	4	....	....
CdO	....	6	....	....	5	....	....	....	....	....	....
PbO	5	....	....	....	....	....	....	....	....	....	10
Na_2O	5	7	5.5	7	7	14	14	7	10	10	9
K_2O	2	....	....	....	....	....	....	....	....	....	....
Al_2O_3	....	2	....	....	....	2	2	....	....	....	....
TiO_2	8	3	4	3	1	....	....	9	2.5	3	7
Softening Point, degrees	738	746	736	743	723	712	732	727	702	716	695
Exp. Coeff. $\times 10^7$	80	81	84	80	76	88	88	82	94	94	93
nD	1.653	1.616	1.641	1.616	1.583	1.586	1.584	1.664	1.616	1.616	1.660
v	41.5	49.4	47.5	50.5	54.1	52.2	51.9	41.2	49.6	49.8	41

The patent contains eight claims. No references were cited by the Patent Office.

Ophthalmic Glass. Patent No. 2,523,265. No drawings. Assigned to Corning Glass Works by William H. Armistead. This glass is for use in making multifocal spectacle lenses, the same as the preceding patent.

Examples are given as coming under this patent, the weight percentages being calculated from the batches, as shown in the above table.

Composition 8 is particularly suitable for combination with a so-called hard crown glass having a softening point of 762° C. and an expansion coefficient of 81.

Compositions 9 and 11 are particularly suitable for combination with a crown glass having a refraction index $nD = 1.523$, a softening point of 727° C. and an expansion coefficient of 93.

The patent contains 12 claims and the references cited were 1,765,287, Scott, June 17, 1930; 1,943,051, Berger, Jan. 9, 1934; 2,297,453, Berger et al., Sept. 29, 1942; 2,431,983, Bastick et al., Dec. 2, 1947; 2,433,883, Armistead, Jan. 6, 1948; and 2,435,995, Armistead, Feb. 17, 1948.

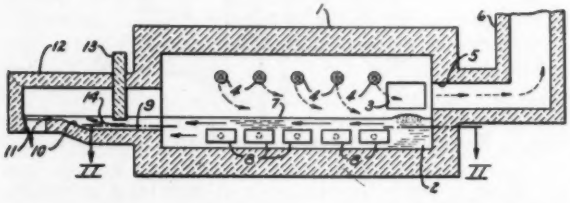


Fig. 2. (Above) Electric Melting Furnace.

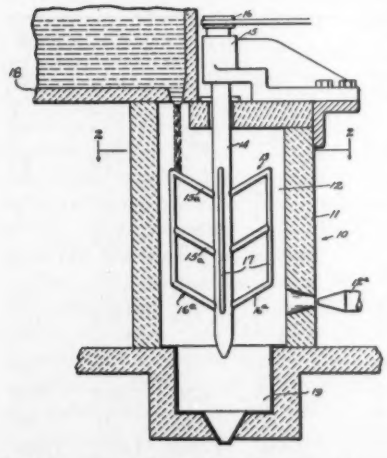


Fig. 3. Apparatus for Mixing Molten Glass.

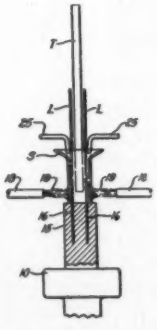


Fig. 4. Sealing Metal to Glass.

Ophthalmic Glass. Patent No. 2,523,266. No drawings. Assigned to Corning Glass Works by William H. Armistead. This glass is for the same purpose as the two preceding; that is, the manufacture of multifocal lenses. It is characteristic of this glass that it contains a substantial amount of ZrO_2.

The following six examples are given of glasses coming under this patent:

	1	2	3	4	5	6
SiO_2	45.8	45.5	36.2	40.5	37.3	35.3
ZrO_2	7.4	7.4	8	7	7	7
TiO_2	1.6	1.6	4.5	9	3.5	3.5
B_2O_3	4	4	5	4	4.3	4.3
CaO	2.5	2.5	2	1	2.5	2.5
ZnO	1.5	1.5	1	2	2.5	2.5
CdO	6	6	7.5	..	..	..
BaO	22.5	22.5	27	20	25	25
Na_2O	6.7	4	7.8	8	7.4	6.4
K_2O	..	3	..	..	..	1
Li_2O	2	2	1	1	.5	.5
SrO	..	..	..	2	..	..
PbO	..	..	..	5.5	10	10
Al_2O_3	..	..	..	..	..	2
*n*D	1.617	1.617	1.654	1.665	1.654	1.654
v	51.2	51	45.3	40.5	43.2	43.1
Softening point, °C.	661	670	665	680	680	683
Exp. Coeff. x 10^7	87	87	87	88	92	92

The patent contains 7 claims and no references were cited by the Patent Office.

Barium Crown Optical Glass. Patent No. 2,523,362.

No drawings. Assigned to Bausch & Lomb Optical Company by Walter A. Fraser, Norbert J. Kreidl, and Lee O. Upton.

There are 8 examples given of glasses coming under this patent, the parts of the oxides being given by weight, as follows:

Examples	A	B	C	D	E	F	G	H
SiO_2 ...	34.7	34.0	32.4	28.7	31.0	31.0	33.25	26.7
B_2O_3 ...	0.7	5.5	6.9	5.0	11.0	11.0	0.75	2.0
Al_2O_3 ..	..	2.5	0.5	7.3	..	..	..	..
TiO_2 ...	2.7	2.5	..	..	..	..	..	3.4
La_2O_3 ..	..	..	7.4	..	..	..	3.5	..
ThO_2 ..	..	5.5	4.2	..	..	..	..	..
ZrO_2 ...	4.0	..	2.7	..	..	..	7.75	4.0
CdO ...	10.0	8.5	6.9	18.5	5.0	5.0	6.75	10.0
BaO ...	46.7	36.5	34.4	40.5	43.0	43.0	42.75	50.0
SrO ...	..	4.0	3.7	..	..	..	..	..
Li_2O ...	0.7	..	..	..	..	..	1.25	1.3
K_2O ...	..	..	..	..	..	..	4.0	..
Sb_2O_3 ..	..	1.0	0.9	..	..	..	..	..
In_2O_3 ..	..	..	..	..	10.0	..	..	..

Characteristics of the glasses resulting from the sample batches are given in the following table which shows the refractive indices (N_D), reciprocal relative dispersions (v), and the time in hours required to produce on the surface of the glass with 1% HNO_3 at 25° C. a film having an optical thickness of a quarter wave length of light.

Examples	A	B	C	D	E	F	G	H
Index (N_D)	1.664	1.650	1.661	1.642	1.650	1.655	1.66	1.690
v	50.0	49.5	56.0	52.0	55.0	55.0	50.0	46.0
Filming Time in Hours.	100.0	0.1	0.2	100.0	0.0	0.0	0.01	0.05

The patent contains four claims and the references cited were 2,144,943, Sharp et al., Jan. 24, 1939; 2,416,392, Hood, Feb. 25, 1947; and 2,435,995, Armistead, Feb. 17, 1948.

Light Absorbing Glass. Patent No. 2,524,719. (Two sheets of drawings, none reproduced.) This invention was assigned to American Optical Company by Edgar D. Tillyer. The invention relates to glasses used to absorb infrared and ultraviolet for use in lenses, filters, and the like.

Six examples of glasses coming under this patent are given. The invention is summarized in one of the seven claims as follows: An ultra-violet and infrared absorbing glass having good visual delineation and a warm rose smoke shade or color, said glass comprising by chemical analysis the following approximate percentages by weight:

Silicon dioxide	70.61
Sodium oxide	8.58
Potassium oxide	8.44
Calcium oxide	9.90
Ferric oxide	1.62
Ferrous oxide	.288
Selenium	.014

and having a spectral transmission such that in the visible region of the spectrum its greatest transmission is in the yellow-orange-red region, with its transmission progressively decreasing to a relatively low transmission in the blue region, thence increasing as it leaves the visible region and again rapidly decreasing in the ultraviolet region to approximately zero and having a relatively low total energy transmission.

The references cited were 1,995,952, Taylor, Mar. 26, 1935; 2,309,071, Sullivan et al., Jan. 19, 1943; and 29,080, Australia, 1931.

Glass Wool and Fiber

Apparatus for Mixing Molten Glass. Fig. 3. Patent No. 2,520,577. (One sheet of drawings.) Assigned to Owens-Corning Fiberglas Corporation by Fay V. Tooley.

A chamber 12 contains a cage 13 arranged to be rotated by a pulley 16. The cage has four radial arms and it is preferably made of a metal such as platinum. The molten glass flows in a stream from a container 18 which may be an extension from a tank. The cage is rotated at a speed of perhaps 30 to 60 R.P.M. The glass flowing over the cage is strung out and thoroughly mixed up. Owing to the shape of the cage, the glass flows off the central shaft to a container 19 from which it may go to a forming machine to be made into marbles or other shapes suitable to be made into fibers. Any cords that there may have been will be changed into very fine evenly dispersed cords which will not do any harm to fibers made from the glass.

The patent contains four claims and the Patent Office cited 13 references.

Miscellaneous Processes

Sealing Metal to Glass. Fig. 4. Patent No. 2,515,706. (One sheet of drawings.) Assigned to General Electric Company by Alfred Greiner and Elliot Q. Adams, this patent discloses a method of sealing leads into lamp bulbs and the like.

The rotary head 10 of a steam making machine supports the stem S and the lamp leads L, L. Burners 18 soften the glass and jaws are provided to press the soft glass around the leads. The stem S is much larger than needed to enclose the parts and tubes 25 are provided to supply carbon dioxide to the inside of the stem while fusing the parts together. It is preferred to provide special tubes for this purpose rather than to use the exhaust tube T.

The Patent Office cited 14 references.

Television Tube. Patent No. 2,518,690. (One sheet of drawings not reproduced.) This invention by H. E. Holman and R. R. Pearce was assigned to Electric & Musical Industries Limited, Hayes, England.

The invention outlines a method of manufacturing an envelope having a glass window of predetermined curvature fused to a surrounding portion of said envelope, comprising the steps of polishing the surfaces of a glass portion to form said window, fusing said polished portion to said surrounding portion of the envelope, and subsequently shaping said polished portion to said predetermined curvature.

The invention can be used in the manufacture of other

(*Continued on page* 604)

Research Digest

The Sodium Hydride Process and Its Application to the Cleaning of Molds For the Glass Industry

The cleaning and descaling of glass molds, as usually carried out, involves expensive hand labor and results in appreciable wear of the mold on account of the abrasive materials which are used. A mold forms scale on its working faces at the expense of metal so that there is inevitably a slow wastage and change of dimensions. In the cleaning and repolishing operation it is, therefore, obviously desirable to limit the loss to the removal of scale and to avoid as far as possible the loss of additional unoxidized metal. Any descaling process which has this advantage would be of immense value to the glass container industry.

In the April 1950 issue of the *Journal of the Society of Glass Technology*, N. L. Evans describes just such a process which, in the place of the application of abrasives, depends on a chemical reaction which affects only the scale and not the underlying metal. Beneath the scale is a mat surface which, when exposed, requires nothing more than polishing to prepare it for further use.

In this process the active agent is sodium hydride, a powerful reducing agent which robs oxide scale of its oxygen, leaving behind a reduced scale in the form of powder metal loosely adherent so that it can be removed by light brushing or by the application of a high pressure water jet.

The chemical reactions are set out as follows:

(a) Formation of sodium hydride:

$$2Na + H_2 = 2NaH$$

(b) Typical descaling reactions:

$$4\,NaH + Fe_3O_4 = 3Fe + 4\,NaOH$$
$$NaH + CuO = Cu + NaOH$$
$$NaH + Cr_2O_3 = 2CrO + NaOH$$

Briefly, the process is as follows: Sodium hydride is formed by a reaction between metallic sodium and hydrogen, the hydrogen being supplied from a cracked ammonia plant. The hydride is used in solution at a concentration of 1-2 per cent in molten anhydrous caustic soda. Caustic soda has a melting point of about 600°F.; the operating temperature of the bath is 660-700°F. Once the article to be descaled has reached the temperature of the batch, the actual reduction of the scale is completed in less than 2 minutes and, in some cases, in as little as 15 seconds. For rapidity of action, the work should therefore be preheated to a temperature of between 570°F. and 700°F. before immersing it in the bath. In the case of bottle molds, an obvious economy is effected by taking them straight from the machine and immersing them in the hydride bath before they have cooled down appreciably.

After treatment in the hydride bath, the next step is to quench the mold in cold water. This generates steam which blasts much of the reduced scale from the mold surface. A final wash in hot water removes any remaining alkali from the metal and, at this stage, brushing with a stiff brush gets rid of the residue of powder metal. The mold is then ready for polishing.

The author summarizes the technical advantages of the sodium hydride process as follows: (1) Speed. (2) Complete absence of attack on the base metal. (3) No hydrogen embrittlement. (4) Good penetration. (5) The same bath is used for all types of metal. (6) The only metals which cannot be treated are such metals as tin and zinc which are attached by alkalies. (7) The whole of the plant is constructed of mild steel. (8) The disposal of residues is simple. (9) There are no dangerous or corrosive fumes. (10) It is impossible to "over pickle".

In the discussion of this paper, the author further stated that safety in operation is taken care of by the design of the plant. The only protective equipment needed when putting work in the bath and taking it out is hat and goggles. When charging in sodium, which is done behind the screen, an asbestos cap and face-shield, and asbestos gloves are used. Rubber gloves are worn when washing articles coated with caustic soda.

Welding flux is readily and completely removed by the process and it is highly likely that sodium fluoride deposits would likewise be removed. Carry-over of caustic soda varies with the design of the articles being treated, presence of "pockets", etc. Draining is important. Normally, however, drag-out is balanced by the formation of caustic soda from the hydride.

Brushing the descaled work off under water is more effective than brushing after drying. Drying appears to cause the reduced scale to adhere to some extent.

The caustic soda-sodium hydride mixture is very penetrating and not only removes carbon formed by the carbonization of oil, but it also reduces any scale which is under the carbon. Carbon itself is not chemically attacked by the hydride bath, but it flakes off the molds.

Caustic cracking is not caused by anhydrous caustic soda, but by strong solutions (30-70 per cent NaOH) at temperatures above 140°F. In view of the washing of trays, floating covers, hydride generators, etc., they should be stress relieved before use by heating them to 1170°F. and allowing them to cool in still air. This entirely prevents the occurrence of caustic cracking.

As the caustic soda removes every trace of oil and grease, the cleaned molds should be given some rust preventative treatment if they are to be kept in stock for any length of time.

Editor's Note: Following are summaries of several papers which were presented before the 52nd Annual Meeting of the American Ceramic Society.

A Study of the Effect of Lubricants on the Adherence of Molten Glass to Heated Metals

The purpose of an investigation by W. C. Dowling, H. V. Fairbanks, and W. A. Koehler of West Virginia University, was to study the adherence of molten metal simulating the conditions found in automatic glassmaking machines. To accomplish this, the apparatus used and previously described by Kapnicky to determine critical

adherence temperatures was improved to reduce several of the operational variables. In addition, the variables of the test were also investigated and their effects upon the precision of measurement were determined.

The test procedure was then applied to the evaluation of glass mold lubricants. In this work the effects produced on the critical adherence temperatures by the lubricants and the persistence of the lubricants on the heated metal samples were studied.

The apparatus, designed and constructed for these tests, was made up of a photoelectric timing unit, an automatic screw feed mechanism, and a heating assembly. The test procedure consisted of dropping molten beads of glass at a temperature of 2200°F., through a distance of 2½ in., onto a polished metal sample inclined at an angle of 45 degrees. The molten bead, in its drop of 2½ in., cools to approximately 2000°F. The adherence time of the molten glass bead to the metal was determined by a photoelectric timer. The critical adherence temperature, Tc, was defined as the highest metal temperature at which the molten bead does not adhere. From a plot of adherence time vs. metal temperature, Tc was obtained as the point at which this adherence curve deviates from the time of free fall.

To qualify this procedure as a standard test, it was necessary to determine the effect of several variable factors on the critical adherence temperature. The factors considered were (1) weight of molten glass bead, (2) temperature of molten glass bead, (3) height of drop, (4) surface roughness of metal sample, (5) slope of metal sample, and (6) accuracy of measurement of metal sample temperature. These factors produced a cumulative error of ±33°F. on the critical adherence temperature of white cast iron which is 680°F.

To determine the mold lubricants for suitability, five characteristics were investigated: (1) effect of lubricant on the heated metal, (2) persistence of lubricant on the heated metal, (3) flammability of lubricant, (4) fumes evolved from lubricant, and (5) deposit left from lubricant.

It was found that lubricants containing free graphite were superior to any other type even though the critical adherence temperatures of silicone lubricants were higher. Those silicones which have high critical adherence temperatures contained a large percentage of silicon which decomposed upon heating leaving a thick, white flaky layer deposited on the metal surface.

The Influence of Base Composition and of Minor Constituents on the Coloration of Carbon-Sulphur Amber Glasses

A. K. Lyle of Hartford-Empire Company discussed amber glasses noting that they have been an almost continuous source of new and recurring problems to glass makers. An extensive review of the statements most frequently repeated are of interest, particularly by way of contrast and comparison with the results and conclusions presented in this paper. Regarding the influence of chemical compositions, it has been stated generally that relatively high alkali content is favorable. The color of amber glasses is thought to be due to iron sulfide or polysulfides. The color is not stable and is easily burned out. The presence of iron is beneficial in preventing loss of color. The use of water in the batch, or the use of hydrated raw materials, bleaches the amber color.

This report is based on an investigation started several years ago as a study of the finding rates of amber glasses. In this investigation, it soon was discovered that amber glasses do not exhibit definite fining rates in the sense that the concentration of bubbles decreases in a regular manner as the melting process is continued. Instead, ambers appear to be of only two kinds: those that bubble and boil until melting is complete and then are almost immediately fined, and those that continue to bubble and boil almost indefinitely or until the amber coloration disappears. Because of these results, the investigation was shifted to a study of base compositions, minor constituents, and coloring combinations.

In the study of the effects of carbon and sulfur, it was indicated that there is a likelihood of there being a preferred combination of carbon and sulfur for a given composition as far as the amber coloration is concerned. In the case of seediness, while it is not possible to draw any broad general conclusions from the limited amount of experimentation, it appears that there is danger of excessive bubbles if too much carbon is used. The general rule may require the quantity of sulfur to exceed the carbon. The use of a definite proportion of carbon and sulfur, such as that provided by the thiocyanate radical (CNS), may be expected to provide a simple means for obtaining the desired depth of color.

Results obtained by the use of hydrated raw materials showed that the presence of water bleached the amber coloration and confirmed the reports found in the literature regarding this effect.

Using a standard proportion of S and C (seven pounds of ammonium thiocyanate per 1000 sand), a series of thirty-five glasses were prepared in order to study the effect of base composition. The resulting colors ranged from light blue through green, yellow-green, and light amber, to a very pleasing reddish amber. When the samples were laid out so as to plot alkali content against silica, a systematic variation in color was evident. Furthermore, contrary to expected results, the high-silica low-alkali glasses were amber while the low-silica high-alkali glasses were various tints of yellow, blue, and green. There appeared also to be a definite boundary between amber and non-amber glasses. This boundary line may be represented by the general equation,

$$S - 2N = K$$

where S = % silica
N = % alkali
K = a constant representing the hue and intensity of coloration.

The equation may be interpreted as stating that for given proportions of coloring agents in the absence of other color modifiers, the coloration produced by carbon and sulfur will be the same for all glasses in which the difference between percentage SiO_2 and twice the percentage alkali is the same. In this series of glasses, amber is produced in all glasses for which the value of K is 45 or greater.

The colors of the glasses of K-value greater than 45 are extremely stable, a 500-pound day tank melt showing no change in color up to 10 days continuous melting. This is quite the opposite of the general impres-

(*Continued on page* 607)

CURRENT STATISTICAL POSITION OF GLASS

Employment and payrolls: Employment in the glass industry during August 1950 jumped sharply to reach 121,800 persons. This is close to 6½ per cent above July's adjusted figure of 114,400. During August 1949, employment had been 107,400, or 4 per cent below this year.

During August 1950, payrolls increased close to 5 per cent to a preliminary $31,346,042. July's payrolls were $29,907,592. During August 1949, payrolls were $26,136,000, or about 20 per cent below August 1950.

Glass container production, based on figures released by the Bureau of Census, was 8,672,525 gross for September 1950. Production during August was 9,133,388 gross, which is 5 per cent higher than for September.

GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

	September 1950
Narrow Neck Containers	
Foods	1,571,640
Medicinal & Health Supplies	1,518,204
Chemicals, Household & Industrial	716,420
Beverages, Returnable	295,446
Beverages, Non-returnable	9,351
Beer, Returnable	298,593
Beer, Non-returnable	283,113
Liquors	973,014
Wines	370,169
Toiletries & Cosmetics	576,702
Sub-total (Narrow)	6,612,652
Wide Mouth Containers	
Foods	2,539,881
Dairy Products	369,255
Home Canning	196,691
Medicinal & Health Supplies	334,271
Chemicals, Household & Industrial	105,358
Toiletries & Cosmetics	146,945
Packers' Tumblers	131,653
Sub-total (Wide)	3,824,054
Total Domestic	10,436,706
Export Shipments	180,344
Total Shipments	10,617,050

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

		Production September 1950	Stocks September 1950
Foods; Medicinal & Health Supplies; Chemicals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	3,491,678	1,791,713
	Wide Mouth	2,549,475	1,311,371
Dairy Products		304,877	191,765
Home Canning		*53,194	79,631
Beverages, Returnable		296,266	512,383
Beverages, Non-returnable		8,203	23,365
Beer, Returnable		287,369	163,070
Beer, Non-returnable		284,947	220,315
Liquors		980,286	360,148
Wines		302,491	158,221
Packers' Tumblers		113,739	53,205
Total		8,672,525	4,865,187

*This figure represents Fruit Jars only.

During September 1949, production was 7,550,490, indicating that September 1950 production is ahead more than 14¼ per cent. Total glass container production at the close of the first nine months of 1950 has reached 77,079,819 gross. Compared with the corresponding period in 1949 when production was 68,133,441 gross, production in 1950 is 13 per cent ahead of last year.

Shipments of glass containers continue to establish new marks, the September 1950 figure of 10,617,050 gross setting a new third highest shipment figure for a single month. Compared with August's all-time high shipments of 11,302,038 gross, the September figure is 6 per cent less. During September 1949, shipments were 8,156,030 gross, or 30 per cent less than for September this year. Total shipments at the three-quarter mark for 1950 have reached 80,893,125 gross. This indicates that shipments at the close of the first nine months of 1950 are 19 per cent ahead of the 68,001,706 gross shipped at the close of the same period in 1949.

Stocks on hand at the close of September 1950 however, dropped considerably to reach 4,865,187 gross. This is a drop of about 27½ per cent from the previous month's stocks of 6,742,617 gross. Stocks on hand at the close of September 1949 were 8,318,335 gross.

Automatic tumbler production for September was 5,903,051 dozens. This is close to 10 per cent less than August production of 6,547,730 dozens. During September 1949 production was 4,769,645 dozens. Shipments for September were 6,080,078 dozens, or more than 15½ per cent less than the 7,222,210 dozens shipped during August. September 1949 shipments were 4,734,449 dozens. Stocks on hand at the close of September were 8,064,364 dozens; at the close of August, 8,091,408 dozens; and at the close of September 1949, 7,618,221 dozens.

Table, kitchen, and household glassware: Manufacturers' sales of machine-made table, kitchen, and household glassware for September 1950 were 3,355,814 dozens, as compared with 3,670,616 dozens sold during August. This represents a decrease of about 8½ per cent. During September 1949, sales were 3,349,273 dozens. Total manufacturers' sales at the close of the 12-month period ending September 1950 were 39,120,588 dozens, or close to 1 per cent less than the 39,503,908 dozens sold at the close of the same period in 1949.

* * *

GLASSWARE PRODUCTION, IMPORTS, AND EXPORTS 1947-1949

On the opposite page, there appears a new summary for the entire glassware industry, including flat glass, containers, and miscellaneous ware for 1947-1949, inclusive.

Prepared by the U. S. Department of Commerce and the U. S. Tariff Commission, the figures are official and show that the total glassware industry of this country has remained about the same for the three years tabulated. Imports, however, have increased for the entire industry about 32 per cent, while exports have decreased about 35 per cent.

GLASS AND GLASSWARE

UNITED STATES PRODUCTION, IMPORTS FOR CONSUMPTION, AND DOMESTIC EXPORTS, BY KINDS

YEARS 1947 TO 1949

Source: U. S. Department of Commerce in Collaboration with U. S. Tariff Commission

Glass and Glassware	PRODUCTION[1]			IMPORTS (Foreign Value)[1]			EXPORTS[1]		
	1947	1948	1949	1947	1948	1949	1947	1948	1949
FLAT GLASS—Total	$ 250,000,000[2]	$ 275,000,000[2]	$ 260,000,000[2]	$ 491,672[3]	$1,052,068[3]	$1,102,898[3]	$15,210,389	$11,548,652	$ 8,706,214
GLASS CONTAINERS—Machine- and Hand-Made Total	$ 425,000,000[2,4]	$ 400,000,000[2,4]	$ 400,000,000[2,4]	$ 365,078[5]	$ 187,685[5]	$ 251,463[5]	$28,479,902[4]	$22,054,058[4]	$19,587,271[4]
PRESSED AND BLOWN GLASSWARE									
Tumblers, Stemware, Table, Kitchen, Cooking and Art Ware									
Machine-Made:									
Tumblers and stemware	$ 31,684,000	$ 30,061,000	$ 31,598,000						
Value added by cutters and decorators	2,000,000[2]	3,000,000[2]	2,500,000[2]				$ 4,292,863	$ 2,265,558	$ 3,222,355
Other table, kitchen, cooking and art ware	50,137,000	42,845,000	39,861,000				14,483,546	8,581,241	$ 6,653,032
Value added by cutters and decorators	1,000,000[2]	1,000,000[2]	1,000,000[2]						
Total Machine-Made	$ 84,821,000	$ 76,906,000	$ 74,959,000	$ 6,085[4]	$ 8,252[4]	$ 7,075[4]	$18,776,409	$10,846,799	$ 9,875,387
Hand-Made:									
Blown tumblers, stemware and other table, kitchen, and art ware	$ 18,262,000	$ 18,388,000	$ 16,156,000	$2,977,348[6,7]	$2,094,000[6]	$2,294,000[6]			
Value added by cutters and decorators	3,500,000[2]	3,000,000[2]	2,300,000[2]						
Pressed tumblers, stemware and other table, kitchen, and art ware	14,844,000	16,252,000	14,581,000	251,186[6]	282,178[6]	289,382[6]			
Value added by cutters and decorators	2,000,000[2]	1,500,000[2]	1,200,000[2]						
Total Hand-Made	$ 38,606,000	$ 39,140,000	$ 34,237,000	$3,328,534	$2,376,178	$2,583,382	$ 1,107,567	$ 408,096	$ 346,755
Total Tumblers, Stemware, Table, Kitchen, Cooking, and Art Ware	$ 123,427,000	$ 116,046,000	$ 109,196,000	$3,334,619	$2,384,430	$2,590,457	$19,883,976	$11,254,895	$10,222,142
Illuminating Ware									
Globes, shades, bowls, etc.	$ 12,176,000	$ 11,937,000	$ 11,323,000	$ 8,143	$ 4,418	$ 4,579	$ 1,659,805	$ 1,378,787	$ 1,517,736
Lamp chimneys and lantern globes	2,156,000	2,159,000	1,607,000	193	1,406	133	884,766	868,643	684,803
Other including prisms, lenses, light bulb blanks, electrical tubing, television, radio and other electronic blanks	44,093,000	49,203,000	64,026,000	844,337	1,780,879	1,508,260	[8]	[8]	1,887,044[9]
Total Illuminating Ware	$ 58,425,000	$ 63,299,000	$ 76,956,000	$ 852,673	$1,786,703	$1,512,972	$ 2,544,569	$ 2,247,430	$ 4,089,583
Technical, Scientific, Industrial and Other Pressed and Blown Ware—Total (Includes Christmas tree ornaments, glass blocks, insulators, and miscellaneous types of glass)	$ 76,880,000[9]	$ 71,782,000	$ 63,266,000	$ 483,516	$ 896,850	$1,797,707[10]	$13,396,796	$11,418,302	$ 7,303,283
Total Pressed and Blown Glass Industry	$ 258,732,000	$ 251,127,000	$ 249,418,000	$4,670,808[11]	$5,067,983	$5,901,136	$35,825,341	$24,920,627	$21,615,008
ALL OTHER GLASS AND GLASSWARE—Total (Includes optical glass and lenses, fibre glass, etc.)	$ 80,000,000[2]	$ 90,000,000[2]	$ 95,000,000[2]	$ 39,092[11]	$ 131,070[11]	$ 112,115[11]	$ 141,640[12]	$ 125,057[12]	$ 1,635,633[12]
GRAND TOTAL GLASS AND GLASSWARE	$1,013,732,000	$1,016,127,000	$1,004,418,000	$5,566,650	$6,438,806	$7,367,612	$79,657,272	$58,648,394	$51,544,126

[1] Preliminary.
[2] Estimated.
[3] Relatively small imports of duty-free stained and painted glass windows and pictorial paintings on glass are included in another commodity group and are not shown on this table.
[4] Almost entirely machine-made.
[5] Largely hand-made.
[6] Almost entirely hand-made. Imports of kitchen articles are believed to be small. Imports of smokers' articles are included in another commodity group and are not shown on this table. Separation of these data into blown and pressed categories is based on trade estimates.
[7] Includes approximately $750,000 of glass jewelry which in later years is included in another commodity group not shown on this table.
[8] Included under Technical, Scientific, Industrial and Other Ware, except for light bulb blanks which are shown for 1949 only.
[9] Includes some products made of purchased glass, the value of which represents a slight duplication.
[10] Includes $350,000 of television tubes, imported under par. 218 (f).
[11] Imports of camera and projection lenses and lenses fitted to instruments are included in another commodity group and are not shown on this table.
[12] Includes ophthalmic glass and blanks and certain fiber glass products in 1949. Exports of sun and goggle glasses and ophthalmic and instrument lenses are included in another commodity group and are not shown on this table.

OVERMYER IRON CLINIC

The Overmyer Mould Company sponsored its second Iron Clinic for glass manufacturers on Wednesday and Thursday, September 27 and 28, at the company's offices in Winchester, Indiana. At this time glass representatives were made acquainted with iron developments that have been achieved in the past year at the Overmyer foundry laboratory.

Jeff Green, of Sorbo-Matt, St. Louis, and consulting metallurgist of Overmyer foundry, conducted the meetings, assisted by Newt Davis, Overmyer metallurgist. Lectures on iron, and experiments being made in perfecting it, were demonstrated with slides and sample patterns and castings. A part of each session was devoted to discussions of mould problems of the glass companies represented.

Following a schedule that included tours of the mould factory and foundry and a golf tournament, the two-day clinic came to a close with a buffet supper at the Beeson Clubhouse. Max Hawkins, Emcee, then introduced the winning golfers and awarded them prizes. C. P. Overmyer, as President of the company, made a short talk, thanking the glass industry for their response to this endeavor and for the many letters urging that the Iron Clinic become a yearly event. With this enthusiasm and the increased attendance over last year, he said, the company hopes to continue the program. He observed that it is an opportunity for members of the glass industry to meet and through association feel free to discuss their mould problems. He said that progress has been made and that, daily, experiments are being carried out to make iron more serviceable.

ONE-COLOR TV MIRRORS AT WESTINGHOUSE

Mirrors that reflect one color of light—red, blue, or green—are in daily use at Westinghouse Electric Corporation for exploration of new methods of transmitting and receiving color television pictures.

By depositing ultra-thin layers of metallic compounds on clear glass (see cover), Westinghouse scientists, in their search for new knowledge and techniques in the fast-developing field of color television, are able to produce mirrors that "see" and reflect only one color. The mirrors are used at both the transmitting and receiving ends of the television system. At the transmitting end, the mirrors pick up the color picture from the camera and break it down into its three basic colors—red, blue, and green—which are sent in the proper sequence through the system. At the receiving end, another set of mirrors "gathers" in the colors, regrouping them in the color picture seen on the television screen.

To make their one-color mirrors, the Westinghouse scientists take a clear sheet of glass and place it in a big, glass-jar "oven" from which most of the air has been evacuated. Then they electrically heat a special metal compound until it melts and sends vapors rising through the glass jar. As these strike the glass sheet, they form ultra-thin layers of a smooth, even film.

The thickness of the film determines which color will be reflected by the mirror. For blue the thickness may be one-fourth the wave length of blue light, or about 16 millionths-of-an-inch. To reflect green light, the layer is made slightly thicker, while red reflection requires the thickest films. The more layers of a particular thickness, the deeper the color.

The films act like "traffic cops" in directing the return of the desired color from the mirror. Although all colors of the spectrum strike the surface, only that one bounces back which corresponds to the right film thickness. All others pass through the mirror so that the eye sees by reflection the desired color and by transmission the complementary color.

PPG INCREASES PRICES

The Pittsburgh Plate Glass Company has announced that it is increasing the price of plate and window glass on an average of 8%, effective immediately.

VISCOSITY

BORAX . . . a small quantity of B_2O_3 in the glass batch will assist in obtaining the proper viscosity.

Another good reason why Borax should be used as an essential ingredient in the container batch formula.

• • •

Our representatives are prepared to discuss all the special advantages of B_2O_3 in glass.

PACIFIC COAST BORAX CO.

Division of Borax Consolidated, Limited

New York • Chicago • Cleveland • Los Angeles

NEW EQUIPMENT AND SUPPLIES

HIGH INTENSITY POLARISCOPE

West Shore Laboratories, P. O. Box 117, Marblehead, Mass., is producing a high intensity polariscope, Model B, with which strains in glass and plastic appear in colors of blue and yellow.

The lenses are ground flat so that the unit may be placed under a microscope or on the production line. The top eye filter is 1¾ inches, including retardation plate; the bottom filter is 2½ inches; the clearance distance between the filter frames is 3½ inches. The overall length of the frame is 7¾ inches.

The opal glass source gives uniform light field and lamps, 110 volt AC or DC, are readily available and easily changed. Lamp sockets are cushioned in rubber to reduce shock.

GLASS TANK BURNERS

Alten's Foundry and Machine Works, Lancaster, Ohio, has announced the completion of the redesigning and improvement of its glass tank burners. The company's release states that its machining set-up guarantees that the tapped outlet which screws to the gas delivery pipe is in direct alignment with the reamed outlet hole on the small end of the burner.

The glass tank burners are made in 1¼", 1½", and 2" sizes and they can be produced with outlet holes to meet specific requirements.

LABORATORY MIXER

Charles Ross & Sons Company, Brooklyn, New York, has announced the development of a new #130-EL motor driven laboratory change can mixer for use in mixing small laboratory batches of from 1 quart to 1½ gallons of material.

The new mixer is reported to mix efficiently most varieties and consistencies of materials and is available in one-gallon and two-gallon sizes. The unit, which can be run on ordinary light circuit, facilitates determination of formulae and other details in pilot sizes prior to production cycles. The mixer is very flexible, having a variable speed motor which permits stirrer speeds within a range of RPM's.

The direction of rotation can be reversed. The double motion stirrers revolve on their own axis and simultaneously around the circumference of the can, assuring a homogeneous mix in minimum time.

PORCELAIN CONE BLENDER

Paul A. Abbé, Inc., Little Falls, New Jersey, has announced the manufacture of a porcelain cone blender designed so that the materials do not come into contact with metal at any point.

The cone holds 56 gallons. The inside diameter at the widest point is 24¼" and the inside length is 46¾".

RADIATION DEVICE SERIES

A completely integrated series of radiation measuring instruments for recording temperatures from 125 to 7000° F. has been developed by Minneapolis-Honeywell Regulator Company, Philadelphia, Pa.

According to the company's announcement, the Radiamatic series now covers measuring of temperatures in destructive atmospheres, of large surface areas, where work moves or rotates, or where temperatures are above thermocouple range. The series includes a low-intermediate radiation pyrometer with a calcium fluoride lens for temperatures from 200 to 1200°F., an intermediate with a fused silica lens for 800 to 2300°, and a high with a Pyrex lens for 1000 to 3200° temperatures. The lenses are available for either narrow or wide angles.

Another part of the series includes a low-range model, chiefly for measuring moving object temperatures, from 125 to 350°F. A third part comprises a small target model for 1700 to 3200°, and a very high model for 3000 to 7000°. The latter is for very small objects or a small area of large objects.

CATALOGUES RECEIVED

Pittsburgh Plate Glass Company, Columbia Chemicals Division, Fifth Avenue at Bellefield, Pittsburgh 13, Pa., has issued a comprehensive 64-page illustrated manual, "Soda Ash", compiled by the technical staffs of the Pittsburgh Plate Glass Company Columbia Chemical Division and Southern Alkali Corporation. It is, according to the firm's report, the newest handbook on the subject and the most complete ever published.

The volume, available without charge to soda ash users and others whose work involves soda ash, gives a completely detailed history of one of the most important basic chemicals.

Chapters are devoted to soda ash production and uses, methods of manufacture, forms and grades, unloading and handling, in fact all pertinent data on this essential raw material which is used to some extent in virtually every industry.

An extensive technical data section, including valuable tables and charts, outlines the properties of soda ash and various methods of analysis.

Hardinge Company, Inc., 240 Arch Street, York, Pa., has published a new catalogue, Bulletin AH-414, describing its recently developed Tricone Mill.

The catalogue contains 12 pages, describing the operating principle of the mill, including a discussion of ball segregation, design features, performance data. There is a discussion of tricone versus cylindrical mills, typical flow sheets for both wet and dry grinding applications, construction details, foundation drawings and dimensions.

Viking Glass Company, New Martinsville, West Virginia, is distributing a brochure, entitled ". . . From American Sands and Artists' Hands", which presents a story with pictures about the creation of America's hand made glass.

The booklet illustrates and describes the steps involved in the manufacture of a piece of glassware. It includes a brief discussion of molds, etching, color, following the process right into the packing room. A well-illustrated section is devoted to pots and their importance in the manufacturing operation. The booklet closes with some examples of Viking glassware.

Geo. P. Reintjes Company, 2513-19 Jefferson Street, Kansas City, Missouri, is offering its Bulletin No. 950 describing how its refractory hung arch not only hangs, but moves like a pendulum.

The bulletin describes the installation and the positive locking arrangement between the lower and the upper tiles, preventing disengagement in service. The bulletin also illustrates the rugged load tests given the double hung arch, not only the load-bearing qualities of the arch but also the strength of the interlock.

Barber-Greene Company, Aurora, Illinois, has issued Bulletin 374 describing the complete range of the firm's Model 374 heavy duty portable conveyor. The bulletin lists fields of use and products handled.

A series of sketches show applications in industry and construction. Accessories such as feeders, screens, hoppers, etc., are pictured and possible usage described. Construction features are illustrated and their operational advantages discussed.

Chicago Wheel & Mfg. Company, 1101 West Monroe Street, Chicago 7, Illinois, has published a new 6-page folder describing its moisture-proofed abrasive cutting wheels.

The folder states that the new heat-sealed glassine envelopes provide the wafer-thin discs with as much as 10% more efficiency than formerly. The booklet illustrates advantages and convenient features of the new development.

Minneapolis-Honeywell Regulator Company, Philadelphia, Pa., has published a new folder entitled "Automatic Measurement and Control of Glass Level".

The new Brown-Beck system which measures and controls level in glass tanks and forehearths is discussed, as well as the control system. The method of operation, schematic drawing, and instrumentation are included. Inquiries should be addressed to Mr. E. B. Sheker, Market Extension.

CHECK THIS NEW *Kahle* WAY FOR MAKING BULBS

INCANDESCENT LAMPS, RADIO TUBES, XMAS TREE ORNAMENTS, ETC.

✓ **FASTER**

✓ **MORE EFFICIENT**

✓ **MORE PROFITABLE**

NEW KAHLE BULB BLOWING MACHINE

- More Efficient—More Compact—Streamlined
- Height Reduced to 130"—Side Supports Eliminated
- Quick-Change Moulds Permit Production of Any Number of Sizes, Shapes, Types, Etc.

CHECK THESE IMPROVEMENTS

—Motor operated cutting knives instead of flame cutting insures more positive and faster production.

—New improved chucks reduce waste of tubing ends.

—New type airblow system, installed on lower part of unit, permits easy adjustment during operation.

Bulbs can be blown into a mould of any feasible design or shape. The glass rotates within the mould, thus eliminating any seam marks. Bulbs can be blown up to 2½" o.d. by 5½" overall length — including stem or tubulation. Speeds up to 2400 per hour.

Four foot lengths of glass tubing are fed by hand. All other operations are automatic including loading. The new Kahle Automatic Bulb Blowing Machine may be equipped with automatic tube feed elevator which returns feeding chuck automatically to loading position.

For further information on this machine or any other Bulb-Making Equipment, communicate with

Kahle ENGINEERING COMPANY

1308 SEVENTH STREET, NORTH BERGEN, N. J.

Tel. UNion 3-6710 — Cable Kahle, North Bergen, N. J.

O. C. NOBLE HONORED AT TESTIMONIAL DINNER

Approximately 100 friends, fellow-employees, and family members gathered together for a surprise testimonial dinner given in the honor of O. C. Noble, President of Tygart Valley Glass Company, on the anniversary of 50 years service to the industry.

Benjamin A. Watts, member of the Board of Directors, introduced E. A. Hinkins, Executive Vice President, who served as toastmaster. A. S. Reese, Vice President and Sales Manager, on behalf of the employees, presented Mr. Noble with a leather chair, ottoman, and end table. He also received a scroll, which was engraved in gold, calling attention to his long and faithful service and signed by all present at the dinner. Mr. Reese also gave an interesting review and paid tribute to the old employees of the company.

Mr. Noble, a pioneer in the glass industry, began working as a young man on October 12, 1900, with the Atlas Glass Company, Washington, Pa. In a short time he rose to the position of assistant superintendent under the late Edward C. Stewart. In 1910 he and Mr. Stewart acquired the plant of the Tygart Valley Glass Company, Mr. Stewart serving as President and Mr. Noble as Vice President. In 1926 the company acquired the present plant, which was formerly the Pittsburgh Sheet Glass Company. With the death of Mr. Stewart in 1935, Mr. Noble was made President of the company.

The testimonial banquet was planned to express appreciation for Mr. Noble's friendship and long years of service. Many congratulatory telegrams were received from business associates and friends.

DONALD E. SHARP NAMED TO INTERNATIONAL GROUP

The election of Donald E. Sharp, assistant director of research in charge of glass technology at Libbey-Owens-Ford Glass Company, as a member of the International Commission on Glass, has been announced.

The commission, which recently met in Berne, Switzerland, represents foremost technical societies dealing with glass technology problems in Czechoslovakia, Germany, England, France, Belgium, Sweden, Italy, and Spain. Mr. Sharp has been with L-O-F since 1943.

ROSSFORD PUBLIC LIBRARY DEDICATED

Rossford Public Library, representing an investment of approximately $75,000 by the glass community of Rossford, Ohio, adjoining Toledo, was dedicated at recent public ceremonies.

The dedication culminated nearly two years of spirited community activity on behalf of a library, and made it the first structure to occupy a site on a four-acre tract of land set aside by the Rossford village council for Civic Center development.

F. S. Huot

J. L. Newton

KOPP GLASS ELECTS OFFICERS

C. J. Huot, President of Kopp Glass, Inc., has announced the election of the following officers of the company: Felix S. Huot, formerly Vice President, becomes Executive Vice President; James L. Newton, formerly Sales Manager, becomes Vice President in Charge of Sales.

Felix S. Huot has been with Kopp Glass since 1928 and his recent duties included complete charge and supervision of plant operations. He will continue in these duties in his new position and, in addition, will assume broader responsibilities.

James L. Newton has been with the company since 1926. He represented the company in Chicago in a sales capacity for several years, going to the headquarters office as Sales Manager in 1946.

PPG, L-O-F, AND UNION SIGN AGREEMENT ON WAGE INCREASE

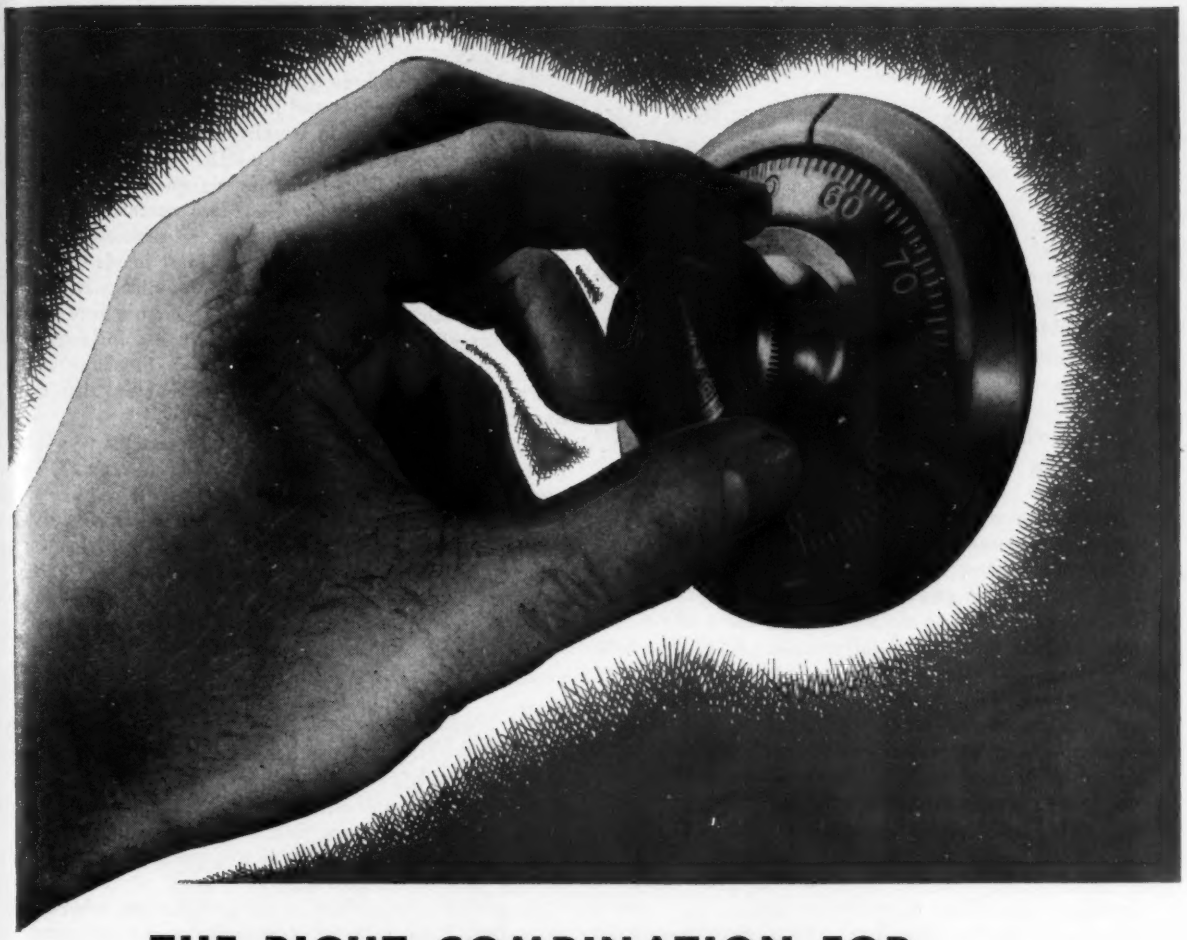
An agreement has been signed by Pittsburgh Plate Glass Company, Libbey-Owens-Ford Glass Company, and the Federation of Glass, Ceramic and Silica Sand Workers of America, C.I.O., increasing the base rate of 18,500 glass workers by ten cents an hour.

All production non-bonus employees will receive an additional four cents per hour increase. The companies also agreed to put one cent per hour in a pool for skilled maintenance employees. The labor agreement between the parties runs until May 15, 1952, without a reopening of any kind. In January of this year, the companies put into effect a comprehensive retirement and welfare program for employees.

J. A. FALLER NAMED TRAFFIC MANAGER AT L-O-F

According to an announcement by L. F. Bryan, Vice President of Libbey-Owens-Ford Glass Company, John A. Faller has been promoted to the post of Traffic Manager. Mr. Faller succeeds H. G. Huhn, who has resigned.

Mr. Faller has been associated with Libbey-Owens-Ford for fifteen years, thirteen of which have been with traffic. He joined the company's mail room in 1935, moving to traffic in August 1937, and continuing there in uninterrupted service except for fifteen months' military leave. Upon his return from the Army in the fall of 1946, Mr. Faller was made assistant to Mr. Huhn.



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HEATING TREATING FLAT GLASS . . .

(*Continued from page* 570)

use of rapid heating cycles unless the thickness is held quite constant. With the soak cycle, an object of any size thickness or color will eventually reach the furnace temperature if left in long enough, but when the furnace is well above the final desired glass temperature, the actual final glass temperature will vary considerably with thickness after a constant heating time. Close control of thickness is necessary to get the fullest advantage from rapid heating.

Chemical composition and colc · also affect the heating rate. These effects are smaller in magnitude than those due to thickness, but they affect the final temperature in the same way. Chemical changes which would narrow the working range of the glass would also be detrimental.

In actual production when glass is inserted into the furnace, the temperature drops and requires some time to recover so that the heating rates are dependent to some extent on the power input and heat capacity of the furnace walls. With an electric furnace using off-on controls, the line voltage will influence the final glass temperature of the rapid or high temperature cycle more than the soak cycle. Also the slow response of some control systems having off-on cycles of several minutes length and large temperature swings will adversely affect the rapid heating cycles. Electronic controllers with very rapid response help reduce this problem.

The whole problem of obtaining the proper final glass temperature under all conditions would be lessened if the actual temperature of each piece of glass could be measured. Some form of optical or radiation pyrometer might eventually be devised, but the transparency of the glass would be a handicap. Thermocouples or other sensitive elements in actual contact with the glass would not be very practical for high production of small pieces.

Besides the problem of achieving the proper final temperature in the shortest time, there is the problem of having that temperature uniform throughout a large plate. Convection currents and infiltration tend to keep the floor of the furnace and lower edge of the glass cold. This can be partly overcome by having additional heat available and perhaps a separate control system for the lower area. When the heating elements are not completely covered by the glass, the edges of the glass will become hotter than the central area and cause warpage or breakage later, unless there is a sufficient soak period at the end of the cycle to allow this excess heat to be distributed by radiation. Variations in thickness in different areas of a single piece of glass will have the same result.

Arguments have been given for and against the rapid heating and soak cycles and in actual practice a balance between these factors is usually reached by trial and error until a suitable cycle is found.

Most tempered flat glass today is quenched with air applied by various means. There are numerous patents covering blast heads using air under pressure. Some patents cover means of moving the blast heads or glass so as to cool all areas of the glass more uniformly. Some use jets of air impinging on the glass from tubes and others use slits. The patents using slits are followed by other patents covering devices to reduce breakage when the glass is so cooled. These suggest that the slits may not be very practical.

Proper design of the quenching device is very important in getting a good product of high strength, but once this device is operating it will generally require less attention and adjustment than the heating device. The cost of quenching may run as high as that of heating.

Tests of the strength of tempered glass are very useful to check results while experimenting and to see if tempered glass will be satisfactory for some intended uses. The American Standards Association specifies that tempered glass for land vehicles must withstand the impact of a ½ lb. steel ball dropping ten feet. The Underwriters' Laboratory requires television glass to withstand the impact of a two-inch diameter steel ball weighing about one pound, three ounces, swinging on a pendulum with five foot pounds energy. Both of these impact tests check only a small area near the point of impact, but they are a somewhat functional test where the glass is to be subject to mechanical abuse.

Another functional test is the pressure test where the glass forms one wall of a chamber under hydrastatic pressure. This test is of value for stratosphere aircraft glazing.

Thermal shock tests by water immersion are a fairly sensitive test of the degree of temper and the presence of any flaws. When the glass is being rapidly cooled the surface will be put in tension as soon as the cooling rate exceeds the cooling rate established when the glass was being tempered. If the supports or other objects have shielded parts of the glass from the air blast, these parts will be in greatest tension and will be the origin of cracks. Cracks formed under these conditions will not cause the glass to disintegrate or dice until later when the glass is cool, and sometimes not at all. The average temperature difference between the hot glass and cold water required to cause breakage is a fairly sensitive test of the degree of temper at the weakest point.

COLUMBIA CHEMICAL NAMES DR. FRANKLIN STRAIN ACTING DIRECTOR OF RESEARCH

The appointment of Dr. Franklin Strain as acting director of research in charge of the Columbia Chemical Division Laboratories at Barberton, Ohio, has been announced by E. T. Asplundh, Vice President.

Associated with Pittsburgh Plate Glass Company's chemical operation since 1937, Dr. Strain has been serving as assistant director of research during the past eight years. Previously, he had been associated with the Barberton Laboratory as a research chemist.

• Lyman H. Allen, Jr., formerly Assistant Chief Design Engineer in charge of Chemical Process Design with the American Viscose Corporation, has been appointed Chief Engineer of Foster D. Snell, Inc. Mr. Allen will be in charge of design and construction of pilot plant operations, spray dryers, plant inspections, by-product utilization, and other engineering services.

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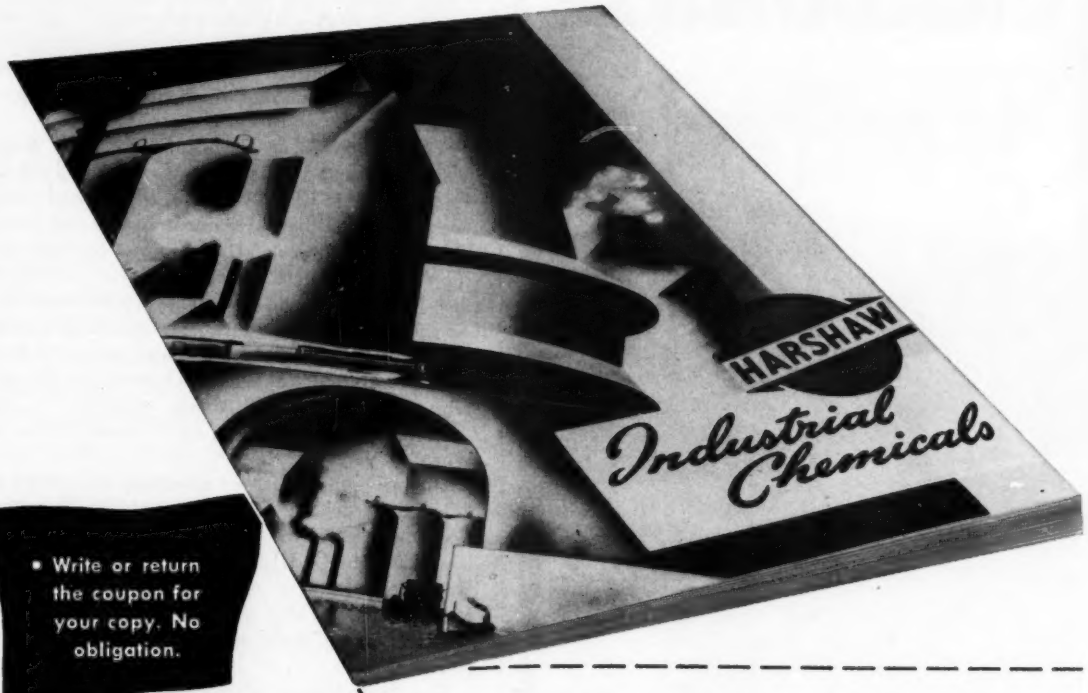

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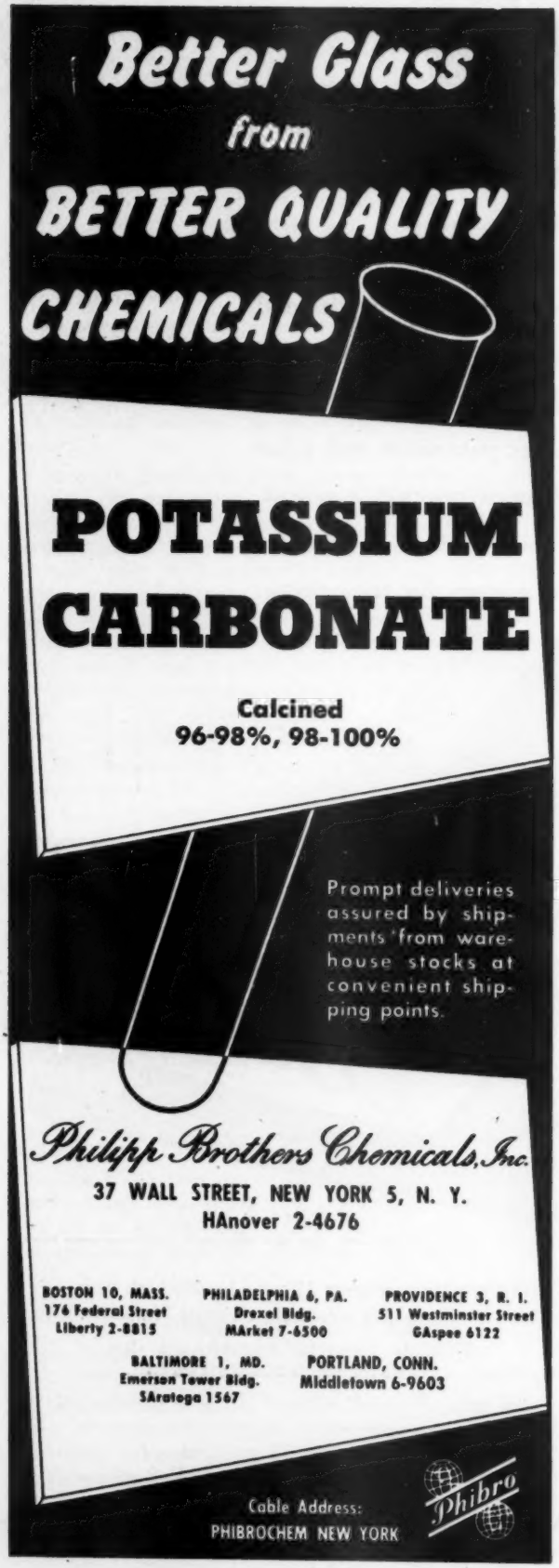


GCMI MEETING . . .

(*Continued from page* 572)

a suggested line of division between narrow and wide mouth ware, as a recommended basis for reporting statistical data.

The Sub-Committee on Beer Bottles and that on Milk Bottles also rendered detailed reports. The first is headed by G. A. Mengle of the Brockway Glass Company, Inc., and the second by W. A. Seger of the Buck Glass Company.

The Committee on Package Design and Specifications, of which G. C. Noblit of the Brockway Glass Company is Chairman, reviewed its activity in directing the package research and development program as exemplified by the Cushion Tester and Strain Gauge Studies, and also in various short-range projects, including those on the serviceability of beer service trays and cases.

Among other details, this Committee reported that the 1949 Color Chart will be revised to show better coverage and higher gloss, and will be dated 1951.

The Committee on Glass Packed Products, headed by J. M. Scharf of the Armstrong Cork Company, reported on the research program at the University of Massachusetts and on the work being done on the asceptic canning process by Dr. Martin of the Schwarz Engineering Laboratory. It also advised that the cooperative work and exchange of information with the National Canners Association will continue in an effort to expand the recognized data and information on glass-packed, low acid foods.

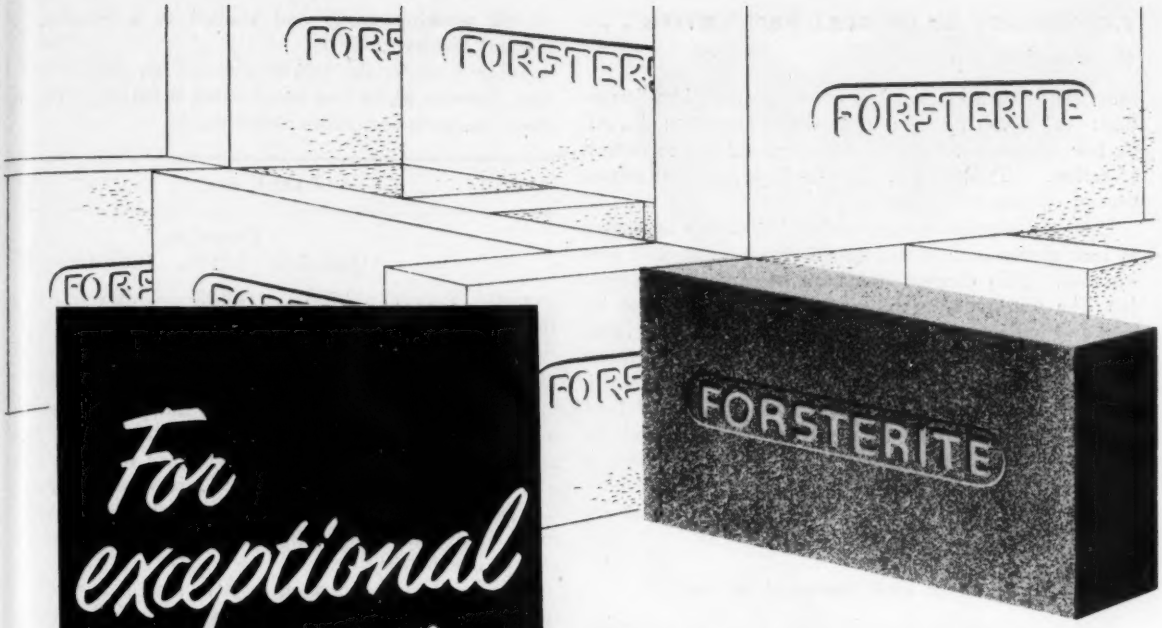
The Committee on Government Industry Relations, of which S. B. DeMerell of the Anchor Hocking Glass Corporation is Chairman, said that it had pledged full cooperation to the government in the mobilization program. Other projects reported on at the meeting include the research project at Battelle Memorial Institute; contacts with government agencies; dissemination of data on imports and exports of glass containers compiled by the government, and circulation of information prepared by the National Canners Association on the volume of fruits and vegetables packed, especially in regard to such glass-packed items as baby foods, catsup, and chili sauce.

On the lighter side, the members and guests of GCMI enjoyed a cocktail party given by the Dominion Glass Company, Ltd.; the Men's Semi-Annual Golf Tournament; and the GCMI Cocktail party and informal dinner. With Bert Gremers of Wyandotte Chemicals doing an excellent job as MC, entertainment that won unanimous approval was furnished by Vivienne Allen and Bert Sheldon.

The Semi-Annual Membership Meeting was held on October 18, at which President Gayner, General Counsel Fred E. Fuller, General Manager V. L. Hall, and Secretary H. W. Kuni made reports.

The 1951 Annual Meeting will be held May 21-23 at The Greenbrier, White Sulphur Springs, W. Va.

• The new Westinghouse Educational Center, a non-profit corporation organized to offer to employees of the company and their families opportunity for further educational and cultural development, was recently opened.



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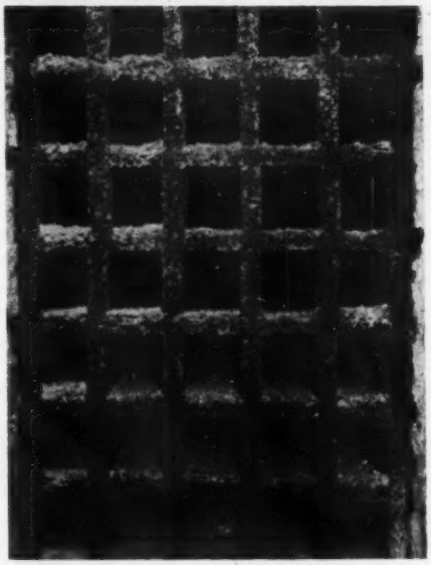

The clean condition of this glass furnace regenerator checker setting of Harbison-Walker Forsterite brick after 18 months of continuous service is typical of many installations.

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VARIABILITY OF OPTICAL PROPERTIES . . .

(*Continued from page* 575)

thus has two extreme ranges favorable for glass formation: (a) Glass formers, and related elements: Si, Al, Be low apparent refraction of oxygen and low refraction of cation. (b) Ba^{++}, Tl^{+}, Pb^{++} — high apparent refraction of oxygen and cation.

Later the conclusion was reached [11] that this assymetry in lead glasses and related systems must affect their free surfaces. This concept was used in several instances: (a) The wetting of crucibles by melts is decreased by lead and iodine[12]. (b) The hygroscopicity of glass is reduced by treatment with lead salts[13] and electrical failure of insulators was diminished by lead borate glazes[14]. (c) The abnormal increase of the surface tension of lead glasses with increasing temperature was explained by the destruction by thermal motion of the arrangement at the surface.[11] (d) The catalytic effect. (e) The phenomena of electrostatic friction of glass spheres was decreased by treatment with lead salts.[11]

Optical Properties and Thermal History

Within a certain temperature range the glass properties change isothermically with time. If glass is quenched at intervals from a temperature of constant heat treatment these changes are observed at room temperature. At the upper limit of this "transformation range" the structure is condensed rapidly and only a little. Therefore, at room temperature a small increase of density and refractive index to an equilibrium which is attained shortly is measured in the quenched samples.

Near the lower limit of this range a considerable condensation is attained very slowly. In a borosilicate crown studied for the purposes of the present investigation, for instance, glasses quenched after a treatment at about 500°C. for two months will be denser by about 1%.

This writer considers[15] this structural change a disorder change resembling similar phenomena observed in alloys. Specific cases of ordering have often been discussed in a speculative manner and might be described, for instance, as follows: (a) Ordering of Na and K in mixed alkali glasses. (b) Coordinative changes of B. (c) Ordering of B and Si environments.

However, there must be a more general attempt to decrease the disorder inherited from higher temperature conditions in accord with entropies corresponding to the respective equilibria, in a similar way as in allotropic modification changes[16]. In glasses the corresponding reactions must, at low temperatures, overcome considerable activation energies.

Recently, the English workers have paid more attention to this question[17].

The present author was greatly interested in the analogous conditions observed in the solid solutions of felspars and ferrites[18, 19]. Just as in glasses, their indices approach in heat treatments at various constant temperatures a series of continuously changing indices of refraction as if approaching a series of "allotropic modifications". These equilibria no doubt attain at higher temperatures degrees of disorder which might be described by the entropies of these solutions.

The author investigated the molar refractions on borosilicate glasses the refractive indices of which a member of his working group had studied as a function of thermal history[20].

Table 8 shows the results obtained on samples of 1 mm. diameter which had been treated at varying temperatures and quenched before measurement.

TABLE 8

	Quenched	Treated at 532°C.	Difference	%
Density	2.495	2.522	.027	1.1
Refractive Index.	1.51238	1.51685	.00447	—
Refraction	.1203	.1199	.0004	.35

The glass treated at 532°C. does not yet possess the highest index and the largest density obtainable by heat treatment of reasonable duration. Higher values will be obtained after two months at 500°C. However, an essential part of the change had been accomplished at 532°C. in a shorter time and the order of magnitude of the change is debatable.

The density has increased by 1%, the specific refraction decreased by .4%. The derivation of the refraction formulae is not of such a nature as to permit a quantitative interpretation. However, one may state that the increase of the electronic deformation on condensation causes a decrease of the refraction, counteracting the increase in index resulting from the simple increase in density.

Irregular Structural Condensation in Glass

The curves describing the change of refractive indices with time at constant temperature which have been worked out in the laboratories of the author do not exhibit any logarithmic regularities. Equations of this type had been used first, for the purpose of permissible approximation, by A. Winter Klein[21]. The useful improvements in those equations which have been proposed by McMaster[22] and Collyer[23] fail, too, to a certain extent.

This is not surprising if the concept of a complex ordering tendency is accepted and if the contrasting influence of increasing density and decreasing specific refraction is admitted.

The absence of a simple exponential law becomes even more evident when the remarkable experiments are considered which recently showed that the isothermic increase of density and refractive index may be temporarily interrupted by a decrease of density and refractive index.

The basic observation has been made by Tool[24] who thus becomes largely responsible for the most recent exploration of vitreous structure. He found that at certain temperatures in a dilatometer a quenched glass is first observed to contract, then to expand, the latter expansion diminishing gradually, perhaps to be followed by slow contraction. He imagines that after condensation of areas around boron ions the environments of silicon may expand with a slower reaction rate when they are, so to say, liberated from the pressure of expanded boron environments.

Recently, Douglas[25] and Jones, in England, have demonstrated this effect in an excellent manner and discussed its causes. Since Douglas prefers Bernal's theories

(*Continued on page* 600)

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VARIABILITY OF OPTICAL PROPERTIES . . .

(*Continued from page* 598)

of the liquid state when he is concerned with the structure of glass, he likes to designate the ordering process which is superimposed on condensation as a tendency furthering expansion as the beginning of unmixing and compares it to the more spectacular phenomenon which has gained practical significance in vycor glasses.

The concepts derived in this brief discourse agree best with these concepts derived from other properties which shun additive methods of prediction. Such concepts have been recently developed particularly by Stanworth[27] and Douglas[25], in part as a consequence of the constructive analysis of the extensive studies of Stevels[26].

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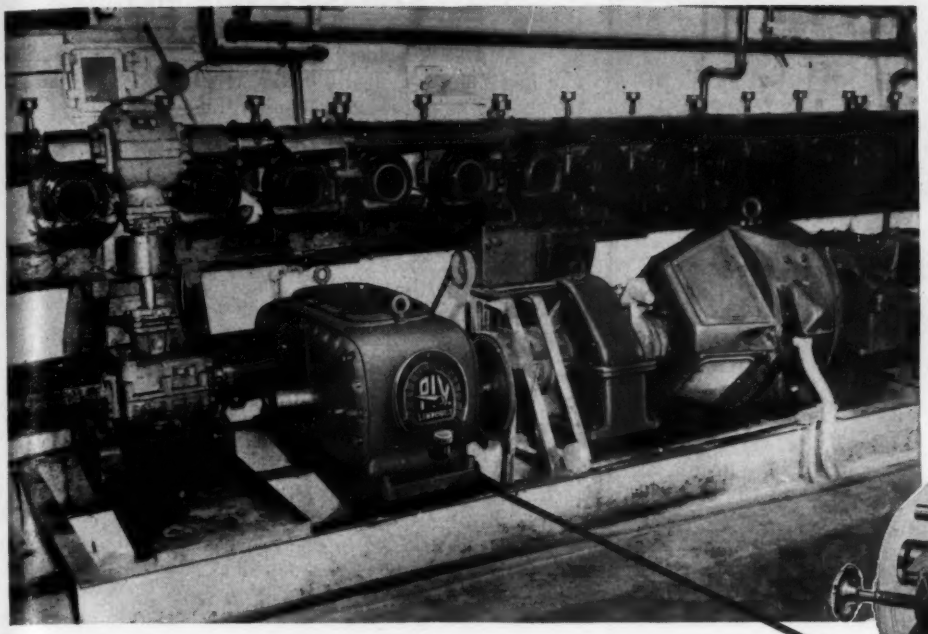

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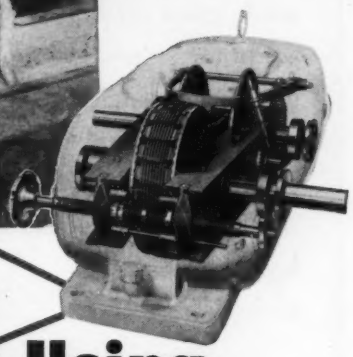

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Speed ratio changes are stepless. Adjustment by easily operated hand wheel permits the most minute variation between input and output speeds, within range of the drive.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg. Offices in Principal Cities.

Wherever synchronous operation of machines requires precise vernier control and constancy of operating speed . . . INDUSTRY USES

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P.I.V. Variable Speed Drive

Science Replaces Empiricism

In recent years the glass industry has made great strides in applying sound scientific principles to all phases of glassmaking—all the way from batch mixing through the lehr to the packing room. And this progress is to be found nowhere more outstanding than in batch formulation . . . specifically in amber glass.

Therefore, when Calumite was offered as the ideal batch constituent for amber glass, it won immediate acceptance.

Its performance in producing quality amber ware has exceeded expectations because with Calumite Company's skilled batch engineering service, it is producing amber ware that works well on machines, is stable and free from seeds and blisters; it produces amber with good reddish tints, and color intensity is maintained from day to day . . . in short, it provides

"A Scientific Approach to Amber Glass Manufacture"

The Calumite Co.
HAMILTON, OHIO

GARLAND LUFKIN DIES AFTER LONG ILLNESS

Garland Lufkin, long a Vice President of Owens-Illinois Glass Company, died Monday, October 23, 1950, in Toledo, Ohio, following a lengthy illness.

One time Manager of the company's Glass Container Division and for several years General Manager of the company's Packaging and Process Research Department, Mr. Lufkin joined the Illinois Glass Company, predecessor of Owens-Illinois Glass Company, in 1921.

During his career with the firm, he had filled many responsible positions. He started as a draftsman with the Illinois Glass Company in Alton, Illinois, in September 1921 and remained in that capacity for two years, later serving as Furnace Foreman, Chief Draftsman and Chief Engineer.

In 1929 Mr. Lufkin was named Chief Engineer for the entire company and moved to Toledo. From 1931 to 1937, he served as plant manager at Bridgeton, New Jersey, and Newark, Ohio. In the latter position, he pioneered the development of fiber glass, which product is now manufactured by the Owens-Corning Fiberglas Corporation. In 1937 he returned to Toledo to assist in the development of the company's closure and plastics products business. He was General Manager of the Closure and Plastics Division from 1937 to 1941 and General Manager of the Glass Container Division from 1941 to 1944.

Surviving besides Mrs. Lufkin are a daughter, Mrs. Hampton Kirchmaier of Detroit, Michigan; his mother, Mrs. Cora A. Hovey, of River Edge, New Jersey; and two sisters, Mrs. Norman Morison, of River Edge, New Jersey, and Mrs. Dave Lamb, of Westwood, New Jersey.

CANADIAN GOVERNMENT FINES NINE GLASS COMPANIES

The nine Ontario and Quebec glass companies, accused of price-fixing by the Canadian government, were fined a total of $44,000 and court costs estimated at $15,000 in Toronto court when the Canadian companies admitted operating as a price-fixing combine for 20 years. Three of the Canadian glass firms were ordered to pay $10,000 each and costs, the maximum penalty, and five others were fined $2,500 each and costs, while the ninth, described as an individual jobber, was fined $1,500 and costs.

Mr. Justice W. R. Treleaven of the Ontario Supreme Court imposed the maximum penalty on Hobbs Glass, Lt., London, Ontario, on Pilkington Brothers (Canada), Ltd., and Consolidated Glass, Ltd., both of Toronto, Ontario. He said these firms were the largest in the group and gained more than the others from the combine's operations. The others were fined $2,500 each and costs, and penalties for the smaller would not be so high that they would be forced out of business. In the case of Lloyd's Glass Co., Hamilton, Ontario, described as an individual jobber, the fine was $1,500 and costs.

"KX-99 Spool Checkers provided constant efficiency, without repair, throughout the life of the glass tank"

A glass company located in the northwestern part of the United States had, like many glass companies, experienced unsatisfactory results in their checker chambers. The checkers they were using clogged, causing reduced efficiency and, even more important, the checker setting needed extensive repairs before the tank itself did.

THEY SWITCHED TO KX-99 SPOOL CHECKERS

A. P. Green Spool Checkers not only outlasted the life of the tank, without needing repairs, but operated with consistently high efficiency throughout the entire campaign. Upon opening the chambers with the KX-99 Spool Settings at the end of the campaign, they found no Spools worn through or displaced. As a result of this outstanding service, they again specified A. P. Green Spool Checkers for use in this and additional furnaces.

This same company is using KX-99 quality brick in arches, sidewalls, division walls, and ports with equally outstanding results.

It will pay you to investigate the advantages of KX-99 for glass furnace use. For recommendations and estimates on your particular requirements, call your local A. P. Green Sales Representative. He's listed in the yellow pages of your telephone directory . . . or write direct.

A. P. Green REFRACTORY PRODUCTS

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Mexico, Missouri, U. S. A.

In Canada
A. P. GREEN FIRE BRICK CO., LTD.
Toronto 15, Ontario

DISTRIBUTORS IN THE PRINCIPAL CITIES OF THE WORLD

(*Continued from page* 583)

envelopes having glass windows. The patent contains ten claims and the references cited were U. S. patents 1,979,573, Pedersen et al., Nov. 6, 1934 and 2,346,470, Cary et al., Apr. 11, 1944.

Glass Cutter. Fig. 5. Patent No. 2,516,668. (One sheet of drawings.) Richard C. Barrett assigned this invention to The William L. Barrett Co., Bristol, Conn.

The cutter comprises a spheroidal wooden hand grip containing a spring acting on the rod 23, the lower end of which has a head 14 carrying the cutting wheel. A screw 29 limits the action of the spring. The head is flat so as to ride against the guide 18. It is stated that this construction enables a workman to cut more glass and with less labor than with the conventional type of cutter.

The following references are of record in the file of this patent: 12,275, Austria, 1903 and 33,821, France, 1928.

Graded Seal. Fig. 6. Patent No. 2,517,019. (One sheet of drawings.) Assigned to Corning Glass Works by Martin E. Nordberg, the invention relates to the joining of two glasses or a glass and a metal, where the materials being joined have expansion coefficients differing too widely to permit their direct union.

The drawing shows a tubular graded seal 10 made up of ten annular sections numbered 11 to 20 having the compositions as given in the following table in which X represents the percentage of ceramic refractory material initially added to the higher expansion glass to raise its deformation temperature.

Section No.	Ceramic Refractory	High Expansion Glass	Low Expansion Glass
	Per cent	*Per cent*	*Per cent*
11.....	X	(100-X)	0
12.....	0.9X	(90-0.9X)	10
13.....	0.8X	(80-0.8X)	20
14.....	0.7X	(70-0.7X)	30
15.....	0.6X	(60-0.6X)	40
16.....	0.5X	(50-0.5X)	50
17.....	0.4X	(40-0.4X)	60
18.....	0.3X	(30-0.3X)	70
19.....	0.2X	(20-0.2X)	80
20.....	0.1X	(10-0.1X)	90

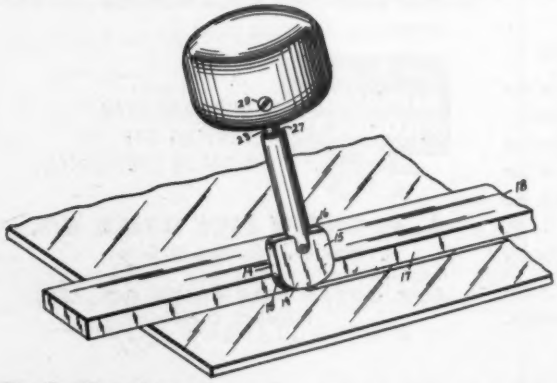

Fig. 5. Glass Cutter.

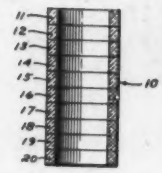

Fig. 6. Graded Seal.

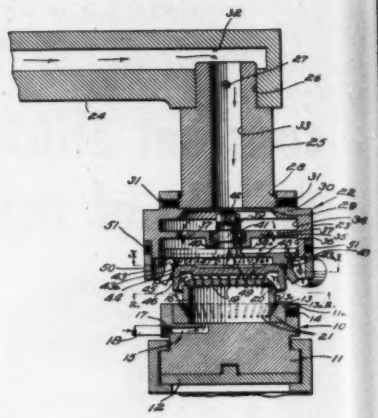

Fig. 7. Tempering Closure Caps.

The ceramic refractory material may consist of several oxides and silicates, alumina being one that is mentioned. The tube thus formed is properly fired and then may be used to join two glasses or glass to metal where there is a wide difference in the expansion of the two parts.

The Patent Office cited 12 references.

Tempering Closure Caps. Fig. 7. Patent No. 2,519,059. (Two sheets of drawings.) Hugh C. MacConnell, Jr., assigned this invention to Hartford-Empire Company. It consists of an attachment to the I. S. machine by which a glass jar closure is subjected to air blasts on all surfaces and at the same time supported and spun by these blasts.

The glass cap is positioned between an upwardly directed blow head 13 and a downwardly directed blow head 23. The upward blast lifts the cap into engagement with some arms which center the cap and are arranged to be rotated with the cap. This rotation is caused by some of the air blasts which are directed tangentially of the cap and arms. Thus the entire surface of the cap is cooled and uniformly tempered. Reference is made to Patent No. 2,284,796 to Berthold for the use of this mechanism.

The following references are of record in the file of this patent: Re. 22,392, Berthold, Nov. 16, 1943; 2,065,862, Long, Dec. 29, 1936; 2,237,343, Engels, Apr. 8, 1941; 2,254,227, Lewis, Sept. 2, 1941; 2,375,944, Quentin, May 15, 1945; 450,464, Great Britain, July 17, 1936; and 833,559, France, July 25, 1938.

Bulb Making Machine. Patent No. 2,523,006. (Three sheets of drawings, none reproduced here.) Assigned to General Electric Company by A. T. Gaskill and C. E. Bock.

The machine shown has three hoppers containing glass tubes, each of which is made into two blanks or bulbs. Automatic means is provided to position the tube, to heat the middle of it, and then to stretch the softened portion. Rollers give an exact form to the reduced connecting neck between the two halves and the two ends are broken apart so as to form two blanks having one end open and a nipple at the other end for tubulating purposes. The whole operation is automatic and uniform blanks can be produced at high speed.

The patent contains 11 claims and 17 references.

"SALES TONIC" FOR GLASS CONTAINERS

Distinctive labels and colorful decorations produced with Du Pont Glass Colors give your product that extra "tonic" that stimulates sales. Du Pont colors are adaptable to simple motifs or the heaviest of multi-layer designs. They're easily applied; give smooth, even applications. And they're durable. Both acid- *and* alkali-resistant, they are unaffected by constant contact with foods, withstand repeated washing and sterilization. Du Pont colors are pretested before shipment so that they always meet the same high standards.

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Make Du Pont your headquarters for glass and ceramic colors of all types, overglaze and underglaze, body, slip, and glaze stains and Squeegee Oil. Also, Du Pont Liquid Bright Gold, a uniformly true metallic decoration that offers exceptional coverage over a wide firing range. For complete information on the use of Du Pont Colors on your products, call our nearest district office: E. I. du Pont de Nemours & Co. (Inc.), Electrochemicals Department, Wilmington 98, Delaware.

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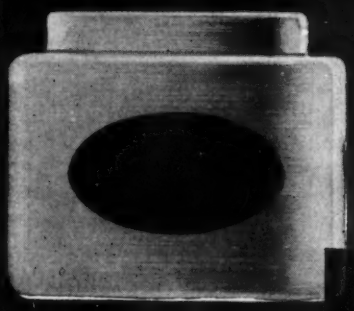

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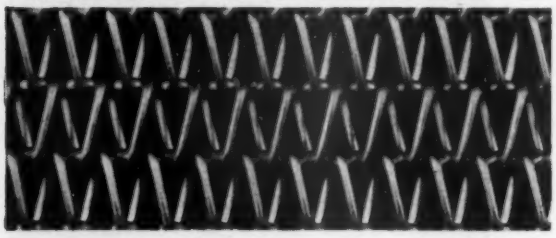

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Because of their open-mesh construction, Wissco Metal Processing Belts provide the advantages of complete heat circulation, low thermal capacity and limited surface contact in the annealing and decorating of glass and ceramic ware.

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AMCO

Design, Erection and Operation of Manufacturing Plants and Furnaces for All Types of GLASS WARE

AMSLER MORTON CORPORATION
CHAMBER OF COMMERCE BUILDING, PITTSBURGH 19, PA.

PACIFIC COAST REGIONAL MEETING . . .

(*Continued from page* 579)

interest in the course of action of glass on refractories and expressed a desire for a continuation of this kind of work. It is possible that Mr. Boumann will have completed color pictures of this general subject in time for the regional meeting in Los Angeles in 1951.

During the banquet, announcement was made of the election of "Pro." Dager as Vice President of the American Ceramic Society. Bill Brandt of Gladding McBean was presented a Certificate of "Fellow of the Society". The banquet speaker, Fred B. Ortman, President of Gladding McBean and Company, reviewed the development and progress of the ceramic industries on the West Coast, much of which he actively participated in. He concluded the speech by pointing out six characteristics that are essential to the success of an individual in industry.

The pattern for future meetings of the West Coast Division of the Society was established at the executive meeting. The next meeting will be in Los Angeles, the following one will be at Seattle, Washington, and three years from this month the convention will return to San Francisco.

The convention ended with visits to the Ceramic Laboratories of the University of California, and the football game between California and Oregon State at which a block of seats was reserved for members of the American Ceramic Society.

PROGRESS IN ACCIDENT PREVENTION . . .

(*Continued from page* 580)

to what to do if an accident occurs and how to use personal protective equipment furnished by the company. Also, how they are expected to do their part in the matter of good housekeeping.

In telling of the accident prevention program in Owens-Illinois plants, Mr. Schaefer compared it to a medical prescription composed of three ingredients—common sense, promotion, and supervision. "Mix well and take in large doses," he directed.

While all three elements of this prescription are important, he stressed the part the supervisor must play in the program. "Unless supervisors are 100 per cent sold on safety and exhibit a sincere interest in doing everything in their power to support a safety program, all is lost," he declared.

Safety operation of standby fuel systems was discussed at the second session of the Section by C. W. Fuston, Jr., of Factory Mutual Fire Insurance Company. Two scheduled speakers were unable to keep their engagements and the conference closed with a spirited open forum discussion covering a safety program for tank repairs in glass plants.

In the election of officers for the Glass and Ceramics Section for 1950-51, James L. Morris of Federal Glass Company was selected as Chairman; J. C. Dittmer, National Lead Company, as Vice Chairman; and Thomas R. Donoghue, Pittsburgh Plate Glass Co., as Secretary.

RESEARCH DIGEST . . .
(*Continued from page* 585)

sion of instability of amber glasses and, indeed, is contrary to the result obtained in the meeting of high-alkali content glasses which lose their color as melting time is prolonged.

Small additions of fluorides were shown to not only cause the amber coloration to become darker, but also to develop reddish tints. This appears to be the first report of the apparent coloring power of fluorides. The author hopes that further investigation of this fluorine effect can be made.

BAUSCH & LOMB ADDS TO CHEMICAL RESEARCH STAFF

According to an announcement by Bausch & Lomb Optical Company, Ernest Vetter, a graduate in Chemical Engineering from the University of Colorado, has joined the Inorganic Chemistry and Glass Research Section of the firm's Chemical Research Laboratory.

It was also announced that Samuel Pozzanghera, a graduate in Chemistry from the University of Rochester, has joined the staff of the Laboratory. Mr. Pozzanghera was previously engaged in physiological and biochemical research at the school of Medicine of the University of Rochester.

NEW SOLVAY DETERGENT REDUCES CORROSIVE ATTACK ON GLASS SURFACES

Recently completed laboratory tests of a synthetic detergent have revealed that it possesses the unique property of reducing substantially the corrosive attack of straight caustic soda solutions on glass surfaces. These tests were conducted by the Application Research Laboratory of The Solvay Process Division, Allied Chemical & Dye Corporation, on the new Solvay detergent, Nytron.

The primary purpose of the work was to seek means to reduce the corrosion of bottles in machine washing, which aggravates the familiar "scuffing" problem of the bottling industry. However, results indicate a possible wider field of benefit in reducing corrosion wherever glass or ceramic surfaces are in contact with alkaline solutions.

Representative tests showed the weight loss of typical Coca-Cola bottles due to caustic soda attack about 14 times less with Nytron in the caustic solution. Weight loss due to corrosion of glass microscope slides was reduced about 210 times compared to the weight loss of test slides a caustic solution not containing Nytron. Maximum inhibition of caustic soda attack on bottles was obtained with small quantities of Nytron, .10 to .25 per cent, in a 2 per cent caustic soda solution. Agitation of the solution prolonged the inhibiting action of Nytron, which averaged two weeks in duration.

A complete 26-page report describing full details of this research project is available without charge upon request to The Solvay Process Division, Allied Chemical & Dye Corporation, 40 Rector Street, New York, N. Y.

• Air Reduction Company has announced the appointment of Dr. E. R. Blanchard as Assistant Manager of the Research Division.

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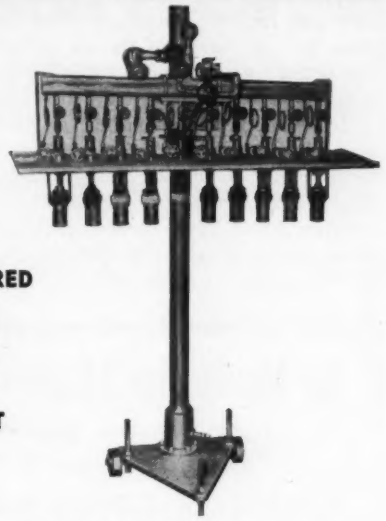

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STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACTS OF CONGRESS OF AUGUST 24, 1912, AND MARCH 3, 1933

THE GLASS INDUSTRY, published monthly at 55 West 42nd Street, New York 18, N. Y., for October 1, 1950, State of New York, County of New York, ss:

Before me, a Notary Public in and for the State and County aforesaid, personally appeared John T. Ogden, who, having been duly sworn, according to law, deposes and says that he is the Publisher of THE GLASS INDUSTRY and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 537, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: John T. Ogden, publisher, 55 West 42nd Street, New York 18, N. Y. Cyril B. Delgado, editor, 55 West 42nd Street, New York 18, N. Y. Managing editor, none. Cyril B. Delgado, business manager, 55 West 42nd Street, New York 18, N. Y.

2. That the owners are: Ogden Publishing Company, 55 West 42nd Street, New York 18, N. Y. John T. Ogden, 55 West 42nd Street, New York 18, N. Y. Katherine Waller Ogden, 55 West 42nd Street, New York 18, N. Y.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of the total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has not reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

(Signed)
JOHN T. OGDEN, *Publisher.*

Sworn to and subscribed before me this 26th day of September, 1950.

David M. Cohen
Notary Public in the State of New York
No. 24-5736200
Qualified in Kings County, Cert. Filed with New York Co. and Kings Co. Clerk and Reg.
Commission Expires March 30, 1952